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CONTENTS

TITLE PAGE 1

FRONTISPIECE
Lawrence Fitch 2

ORIGINAL PAPERS
A Keratoscopic Survey of 13,395 Eyes.
Henry W. Hofstetter 3
The Relationship Between Refractive State of the Eye and Intelligence Test Scores.
Monroe J. Hirsch 12
Partial Cycloplegia and the Accommodation-Convergence Relationship.
R. C. Van Hoven 22

EDITORIAL
A Report on the Academy.
Carel C. Koch 40

TRANSACTIONS OF THE ACADEMY
Academy Holds Succesful Boston Meeting.
Carel C. Koch 43
Fitch Appoints Academy Committees 49
Annual Report of the President.
Robert W. Tubesing 51

CURRENT COMMENTS 54

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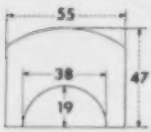

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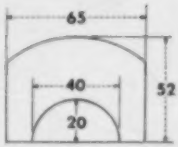

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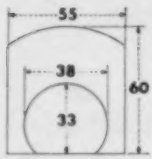

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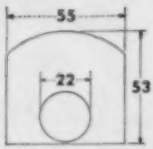

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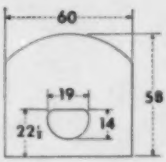

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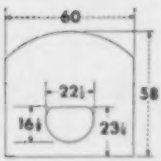

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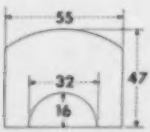

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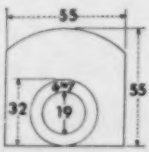

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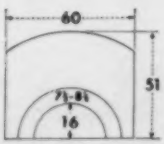

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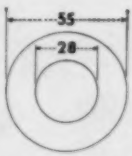

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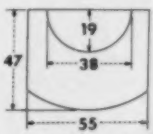

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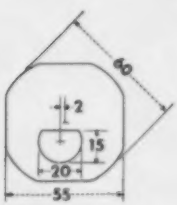

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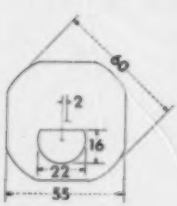

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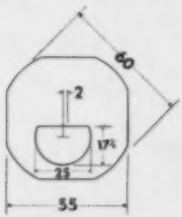

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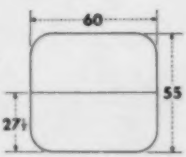

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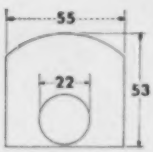

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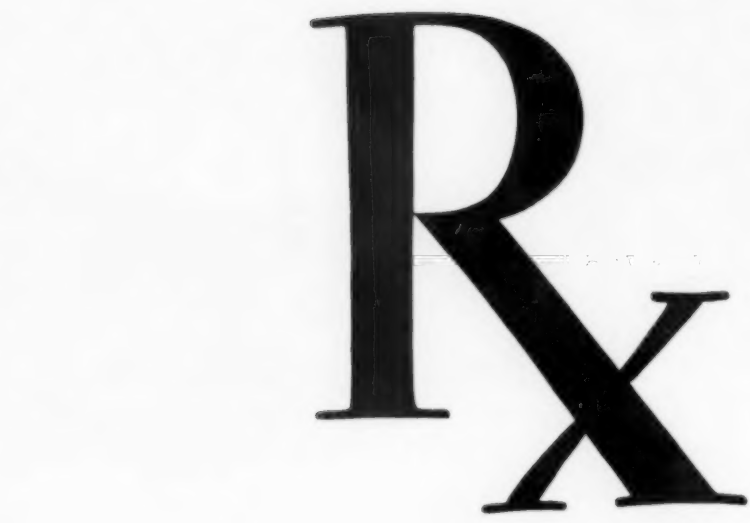

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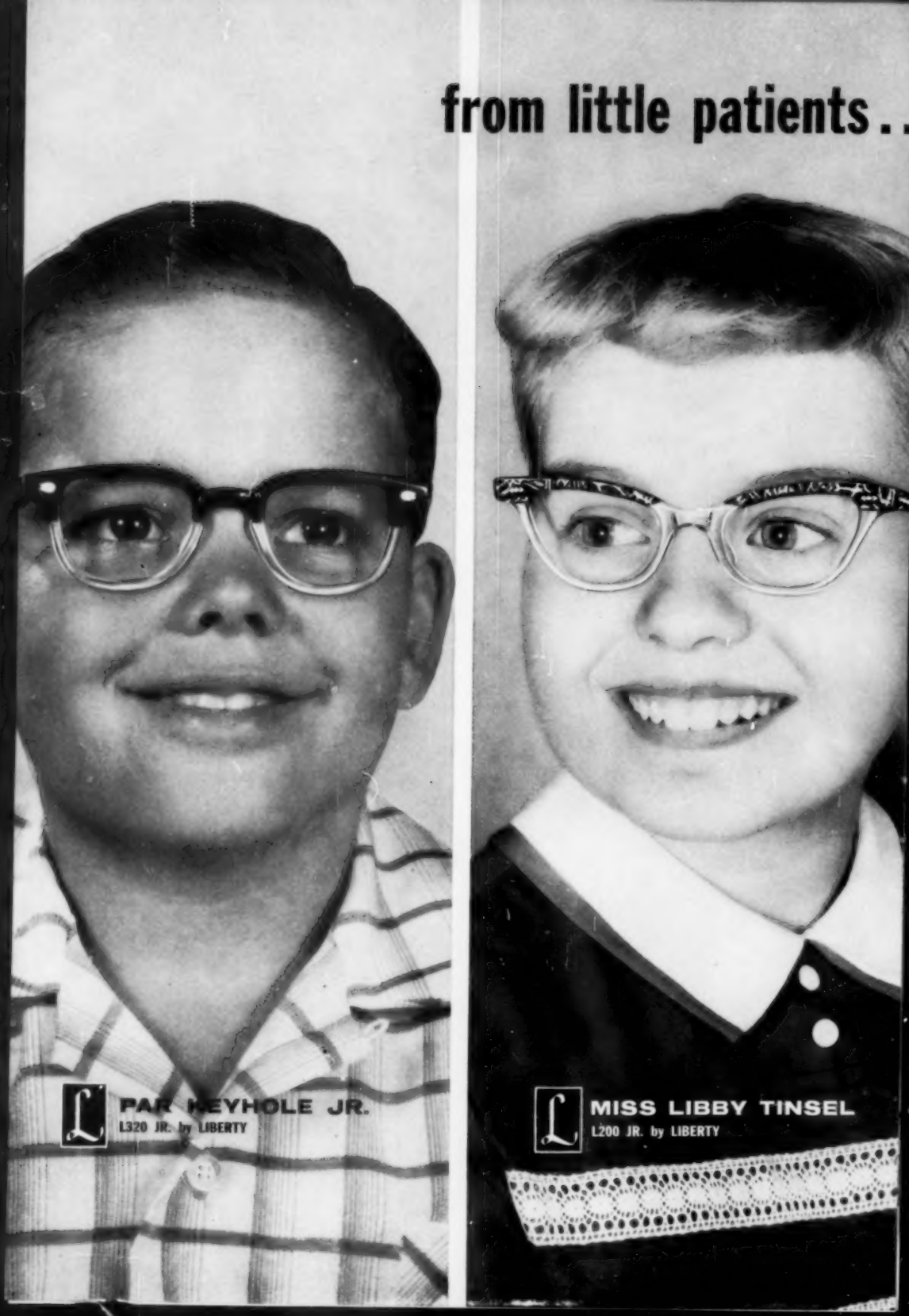

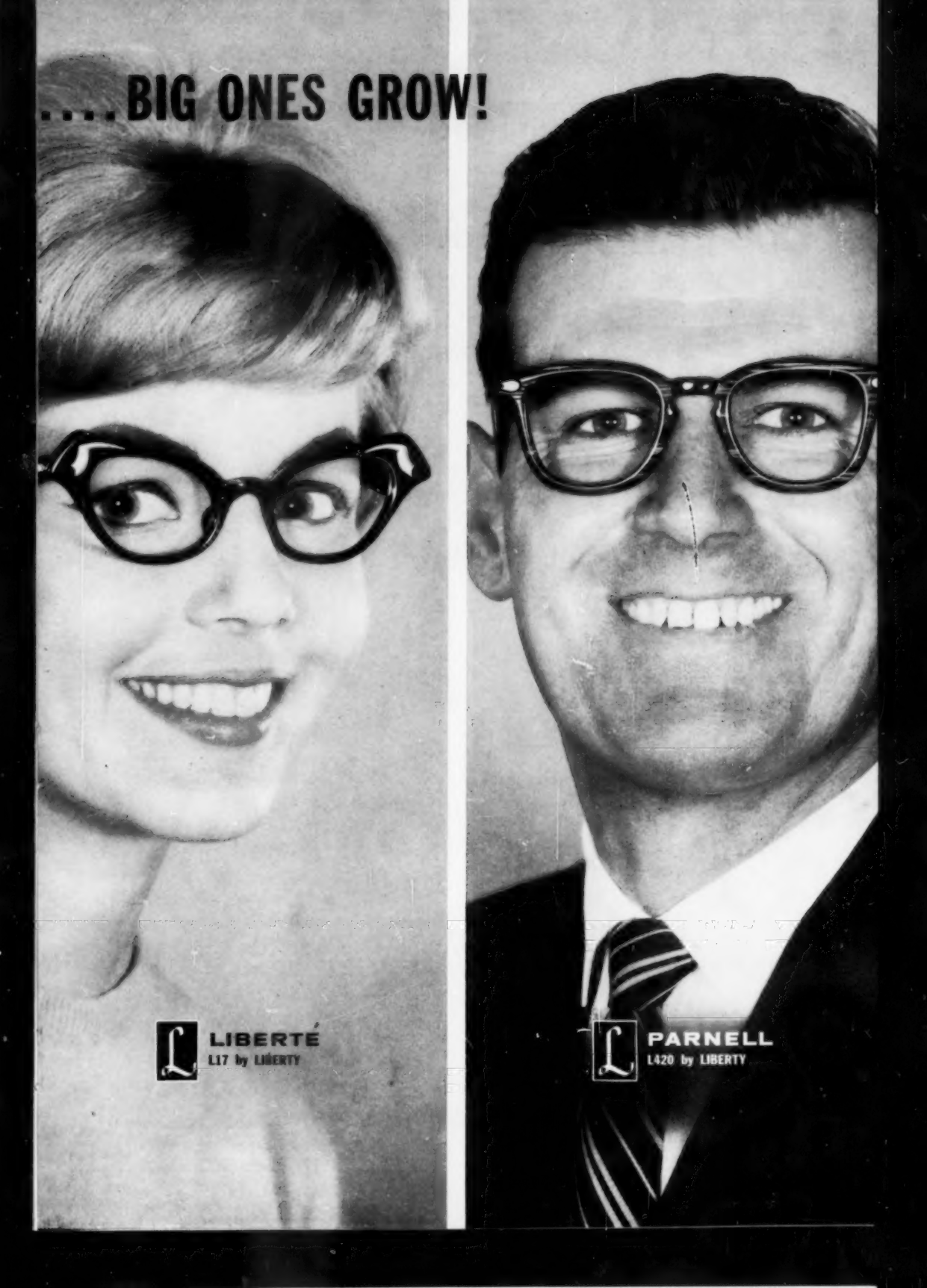
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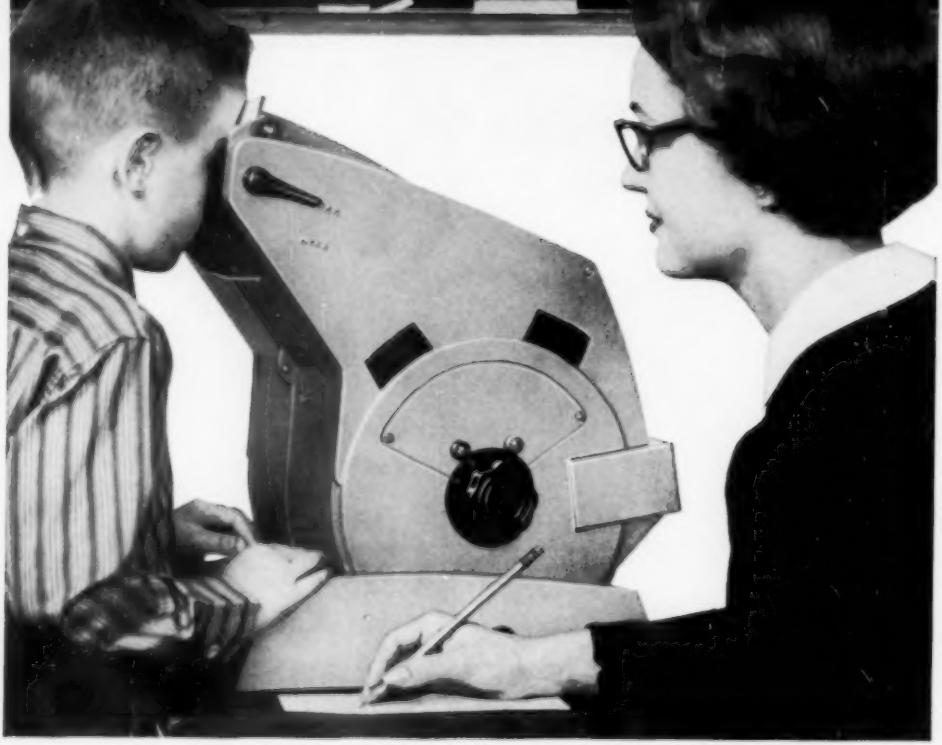

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1959

Lawrence Fitch

[see page 43]

AMERICAN JOURNAL OF OPTOMETRY
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AMERICAN ACADEMY OF OPTOMETRY

Vol. 36 January, 1959 No. 1

A KERATOSCOPIC SURVEY OF 13,395 EYES*

Henry W. Hofstetter†
Division of Optometry, Indiana University
Bloomington, Indiana

INTRODUCTION

Keratoconus (conical cornea) is generally considered an obscure condition devoid of any marked symptoms in its early stages. The classic technique of identification is by means of the keratoscope or Placido disk. The condition is regarded by some as a late developmental anomaly and by others as a dystrophic condition. Clinical reports suggest its usual manifestation in youth or adolescence, more commonly in girls. It is frequently described as progressing slowly and gradually for five or six years, after which it may become arrested, sometimes recommencing later. Clinical reports indicate that the condition is characteristically bilateral, although typically one eye is decidedly worse than the other.

Because of its elusiveness in a routine clinical examination, the absence of clearly indicative subjective symptoms, and its relative rarity, its prevalence in the general population is not accurately known. The presently reported survey was, therefore, instituted as an exploratory study of its prevalence.

PROCEDURE

The survey was made as a part of the Indiana University research and education exhibit at the 1957 Indiana State Fair in Indianapolis. The project was manned during the ten-day period by 25 different volunteer optometrists‡ working individually in four-hour shifts, usually with a recording assistant. Some worked several shifts, but most of them worked only a single four-hour period.

The instrument, illustrated in Figure 1, consisted of a transilluminated pattern (P,P′) of concentric black rings with a central

*Read before the annual meeting of the American Academy of Optometry, Boston, Massachusetts, December 14, 1958. For publication in the January, 1959, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist, Ph.D., Director of Division, Fellow, American Academy of Optometry.

‡Appreciation is expressed to the Indiana Optometric Association for its cooperation and assistance in this project.

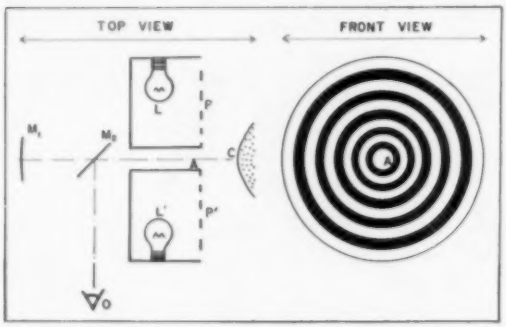

Fig. 1. Diagram of keratoscopic viewing system.

aperture (A) behind which was a very slightly concave front surface mirror (M_1) which permitted the subject to view the image of the keratoscopic pattern on his own cornea (C). Also behind the aperture and in front of mirror (M_1) a transparent front surface mirror (M_2) mounted at 45° from the axis of the keratoscope permitted a simultaneous view of the pattern on the subject's cornea by the optometrist (O) in attendance. The pattern had a total diameter of 9 in. and was transilluminated by four incandescent light sources (L,L'). The pattern was constructed of translucent white plastic faced with a series of five concentric opaque rings, as illustrated.

The subjects were induced to peer into the keratoscope by the opportunity to compare the patterns on their own corneas with artists' drawings of characteristic clinical patterns on display next to the instrument. Further, the optometrist in charge described the apparent features of each subject's keratoscopic pattern as it was viewed simultaneously by both. In addition, a brief printed technical statement describing keratoscopy and the conditions it detects was made available to each participating subject.

The attendant optometrists were each provided with complete mimeographed instructions for manning the keratoscopy project. The following paragraphs taken from these instructions relate specifically to the keratoscopic examining procedure:

> The optometrist in attendance will observe each viewer's keratoscopic pattern simultaneous with the viewer observing his own, calling his attention to characteristics of the pattern, effects of the distance on pattern size, interference of eyelashes, eccentricity with respect to the pupil, etc. Usually the viewer's spectacles will have to be removed to eliminate lens reflections. The optometrist should enter on his record sheet a tally mark for each pattern observed, two marks to be recorded if both eyes are viewed. The optometrist may ask either or both of two basic questions to help him in his search for unusual keratoscopic pattern characteristics, but he should not use the answers to decide the type of pattern present. These questions are, essentially, "Do

you have good vision in this eye?" and "Was this eye ever injured or diseased?" Beyond these elementary inquiries a case history should not be attempted. In answer to the question, "Are my eyes O.K.?" the viewer should be told only the interesting features of his keratoscopic pattern. The keratoscope does not provide information beyond that.

The tally classification should be made as follows:

SPHERICAL: The keratoscopic pattern in the central two-thirds cornea is perfectly *circular*, though not necessarily centered with respect to the pupil. Keep in mind that the number of keratoscopic rings seen within the middle two-thirds of the cornea is related to the distance of the viewer's eye. Hence your judgment may be based on a single ring or on several rings, whatever number of rings may be observable in the central two-thirds of the cornea.

ASTIGMATIC: The pattern is noticeably *elliptical*.

IRREGULAR: The pattern (in the middle two-thirds of the cornea) shows *kinks, waviness, fuzziness*, or *obliteration* not atttributable to eyelashes or ptosis.

KERATOCONIC, DOUBTFUL: Pattern seems to be *slightly oval* (egg shaped) but you are not certain.

KERATOCONIC, DEFINITE: Pattern is *oval*.

Please classify each viewing eye in one category only. If the eye fulfills the criteria for two classifications, record the tally only in the column representing the more prominent condition. If the two conditions seem equally prominent, record the tally mark in the column further to the right, e.g., if the pattern shows both "astigmatism" and "irregular," place the tally under "irregular." Explanatory comments in the margin are, of course, permissible.

The observation can be improved by asking the viewer to fixate in appropriate sequence the upper, lower, right, and left "edges" of his own eye, thus placing the pattern in slightly different positions in the central two-thirds of his cornea.

A supply of mimeographed tally sheets enabled each optometrist to keep his own record of observations. The tally forms were organized into two tables on each sheet, one for males and one for females. Each table was spaced vertically for 10-year age intervals and laterally for five categories of patterns: "spherical," "astigmatic," "irregular," "keratoconic doubtful" and "keratoconic definite."

The circumstances preliminary to establishing the project did not permit any supervised training sessions for the optometrists nor any opportunity to eliminate certain ambiguities and oversights in the instructions. For example three of the optometrists failed to make separate tally entries for males and females during portions of their time. Also, some routinely observed only one eye of each subject, some routinely observed both eyes, and some did either one or both as elected by the individual subjects.

RESULTS

The results for the total group are shown in a combined tally for males and females in Table I. A total of 50, 0.37% of the total group, were checked as keratoconic "doubtful" or "definite," by reason of the oval appearance of the keratoscopic pattern.

A number of incidental observations and analyses serve to indicate the level of integrity of the observations, as follows:

1. Of the 25 participating optometrists, only 16 reported seeing

TABLE I

Composite of tallies for males and females combined, approximately 50% of each.

Age	Spherical	Astigmatic	Irregular	Doubtful	Definite
0-9	987	76	8	1	0
10-19	2,848	392	47	4	0
20-29	1,757	284	37	3	1
30-39	1,971	348	38	6	3
40-49	1,710	282	50	6	6
50-59	1,124	213	44	7	4
60-69	689	113	47	4	2
70-79	221	38	21	3	0
Total	11,307	1,746	292	34	16

one or more keratoconic patterns. Of these 16, only four recorded oval in both the "doubtful" and "definite" categories: the other 12 entered their tallies in only the "doubtful" or only the "definite" category, suggesting that the classification of oval patterns into "definite" or "doubtful" was a matter of varying individual caution on the part of the observers rather than a relative frequency characteristic of the population. In fact, the two who reported only "definites" showed a higher mean percentage of keratoconic tallies than the ten who reported only in the "doubtful" category. These latter ten averaged only 0.3% keratoconic cases as compared to 0.37% for all 25 observers.

2. The nine observers who noted no keratoconic patterns made an average of only 320 observations each, as compared to the average of 657 observations for those who noted one or more keratoconic patterns. In other words, those who failed to note any keratoconic patterns could not be presumed, on the basis of statistical probability, to have

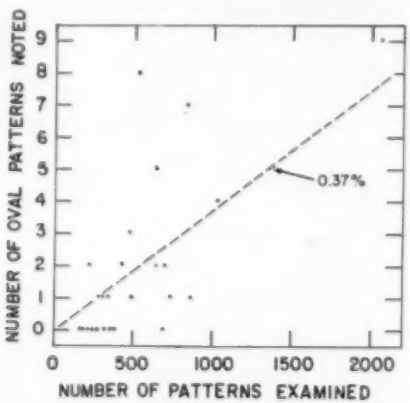

Fig. 2. Scatter plot of the results obtained by 25 different optometrists showing the number of oval or keratoscopic patterns noted in relation to the number of patterns examined by each.

overlooked actual cases. The reliability of the 25 observers is shown to be quite high by the apparent correlation of the number of detected keratoconic patterns with the number of patterns examined by each observer, as plotted in Figure 2.

3. The distribution of per cent of keratoconic patterns noted by each of the 25 observers shows a mode at about 0.3% as well as at 0.0%. This is illustrated in Figure 3. The mode at 0.0% reflects

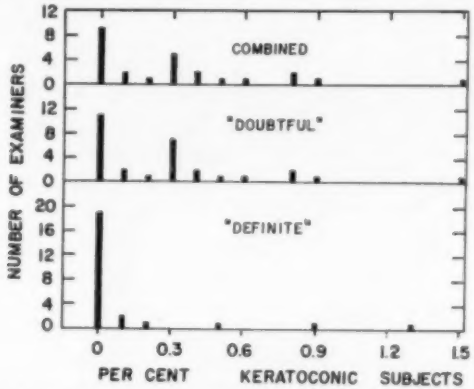

Fig. 3. Bar graph showing the number of examiners making each of a series of per cent scores computed from the number of "definite" or "doubtful" keratoconic patterns detected in relation to the total number of patterns examined.

the result of those who examined too few to anticipate a single keratonic pattern by statistical probability. The more centralized mode at 0.3% tends to support the reliability of the above computed mean prevalence of 0.37%. Figures 2 and 3 both suggest a rather uniform distribution of keratoconic patterns in the total population sampled.

4. The per cent of "irregular" and "astigmatic" patterns noted by each of the 25 observers showed no correlation. Since no correlation of these two types of patterns would be anticipated, this statistical confirmation tends to rule out any prejudicial or proficiency-weighted tallying on the part of the participating optometrists. In other words, if the optometrists differed significantly in their skill in differentiating the pattern types, or if some of them manifested any predispositions to distribute the tallies more or less freely in the several categories, a spurious correlation should have manifested itself as a resulting artefact.

5. The simultaneously tallied data on "irregular" and "astigmatic" patterns showed significantly different relationships with age, relationships which are in accord with other indirectly comparable data. These relationships are shown in Figure 4. In this figure, the

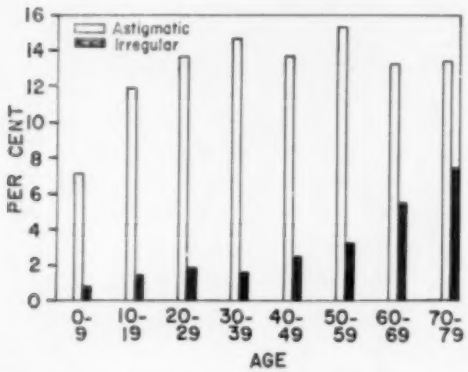

Fig. 4. Bar graphs showing the per cent of keratoscopic patterns classified as elliptical (astigmatic) or irregular at different age levels.

"irregular" pattern shows a continuously increasing prevalence with age, a trend which would be predicted on the assumption that the irregular pattern has a wide variety of causes quite unrelated to any restricted phase of growth or maturation except, perhaps, advanced age. The astigmatic pattern however shows a significant increase in prevalence during youth and a relatively constant prevalence during adult life. The per cent showing astigmatic patterns suggests that this classification represents corneal astigmatism of about 1.50 diopters or more, hence would not be expected to reflect the changes in small amounts of astigmatism sometimes associated with age.

Neither the "astigmatic" nor the "irregular" patterns showed significant sex differences in prevalence.

6. Unfortunately the data on the tally sheets did not permit a meaningful evaluation of the bilaterality of prevalence of the keratoconic patterns except in a few instances where the recorders added notations to the effect that a pair of tally marks represented the two eyes of a single subject. Where a single tally mark occurred in a given age and sex category for a single observer, it could be assumed either that only one eye manifested the keratoconic pattern, that the tally mark represented one person instead of one eye, or that only one eye of the subject was examined. Six of the 16 "definite" tallies and 26 of the 34 "doubtful" tallies were so recorded. The others, when not accompanied by an explanatory notation, could not be evaluated in terms of this question.

7. Subsequent discussions with the participating optometrists indicated considerable lack of confidence in their results, most of them

voicing the opinion that they may have missed some of the keratoconic patterns. This attitude appeared to be identified with the lack of co-operation on the part of many of the subjects, especially subjects who merely wanted a quick or casual glimpse, and subjects who seemed unwilling to discuss or exhibit their afflictions under conditions that afforded no privacy.

The subsequently expressed opinions of the attending optometrists further indicated that the keratoconic patterns labeled "doubtful" were in fact truly oval, but that their classification in the "doubtful" column reflected a clinically indoctrinated reluctance to label them "definite" without additional supporting evidence which they had no opportunity to secure under the circumstances of the project.

The prevalence of keratoconic patterns obtained for each age level and for each of the sexes is shown in Figure 5. Both the "definite"

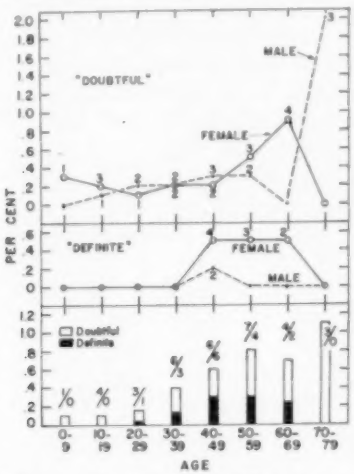

Fig. 5. Prevalence of keratoconic patterns at different age levels. The top graph represents the patterns classified as "doubtful" keratoconus, and the middle graph represents those classified as "definite," for males and females separately. The numerals represent the actual number of cases for each point on the graphs. The bottom graph shows "doubtful" and "definite" combined. The fractional numerals represent the actual number of "doubtful" cases over the actual number of "definite" patterns.

and "doubtful" categories suggest its predominant prevalence among adults. The major increase in prevalence appears to be associated with early adult life. The prevalence seems to be greater among females than among males.

DISCUSSION

At best the results of this exploratory survey seem only to raise

more questions than they answer. The difficult problem of evaluating the reliability and validity of the keratoscopic observations under the restricted conditions of the projects has already been elaborated on in the above presentation of the results. Further than that there must be considerable doubt as to the representativeness of the population sample. The Fair itself is primarily an attraction to the rural populace, whence the prevalence of ocular anomalies may be at a minimum if acuity studies constitute a reliable index. There can be no assurance that persons afflicted with keratoconus would attend such a fair in the same proportion as persons without comparable visual defects. There may also be an economic selectivity since attendance of the fair typically involves considerable travel, time, the price of admission, and the anticipated cost of patronizing the commercial concessions.

There may even be considerable self-screening within the project itself, since, to participate, the subject must "look" into the instrument. It can be quite legitimately suspected that a person who is severely afflicted with keratoconus and the concomitantly very low acuity would be reluctant to participate in an activity apparently requiring reasonably normal ability to see. Finally, if the condition is monocular, it can be suspected that the subject would normally do his looking with only the better eye unless he were fully familiar with the nature of the study.

In spite of this unfortunate lack of controls, there is some reassurance to be derived from the fact that the results obtained here disagree with clinically derived opinions in only one specific aspect, namely, with regard to the characteristic age of onset of keratoconus. The present data suggest early adult life as the characteristic age of onset, whereas the clinical observations point to early adolescence. This is a difference of 10 or more years. It may well be that both types of sampling, the clinical and the fair attending group, exaggerate this difference. Clinical population samples typically show a very reduced frequency of eye examinations in the age range from 20 to 40, which would tend to emphasize the apparent frequency at the younger age levels. On the other hand, the persons in the younger age group who manifest the condition of keratoconus are likely to be under greater surveillance of parents, teachers, and agencies concerned with subnormal vision and hence less free to attend public events of the nature of a state fair.

SUMMARY

The keratoscopic inspection of 13,395 eyes of subjects attending the 1957 Indiana State Fair showed the following prevalence of types of corneal reflection patterns based on their appearance as "spherical" "elliptical," "irregular," or "oval."

1. Approximately 0.6% of the adult population showed the oval or keratoconic type pattern, with a higher prevalence among women than men, and with virtually no increase in prevalence after age 40. Only 0.1% in the 0-19 year age group showed this pattern.

2. The prevalence of "irregular" patterns arranged continuously and gradually from less than 1.0% in the 0-9 year age group to 7.4% in the 70-79 year age group.

3. The prevalence of "elliptical" or "astigmatic" patterns increased from 7.1% in the 0-9 year age group to 13.6% in the 20-29 year age group, and persisted at approximately the latter level through all older age groups.

The limitations, reliability, validity, and interpretation of these data are discussed.

ANNOUNCEMENT

HENRY A. KNOLL MOVES TO BAUSCH & LOMB AT ROCHESTER

Dr. Henry A. Knoll, former dean, Los Angeles College of Optometry, has joined the scientific staff of the Bausch & Lomb Optical Company, Rochester, New York, October 1, 1958.

Dr. Knoll is a resident of Cliffside Park, New Jersey. He received his B.S. degree in Optics at the University of Rochester, 1944. For the next two years he was engaged in scientific work on infra-red light in the U. S. Navy. He received his M.S. degree in 1948 and also his Ph.D. degree in Physiological Optics in 1950 at The Ohio State University, Columbus.

He then served as a member of the faculty of the Los Angeles College of Optometry from 1950 to 1953 and as dean of the school until 1955. At that time he joined the faculty of the University of California, Los Angeles, as a research biophysicist where he remained until 1958 when he had become a research worker in physiological optics on the staff of Dr. Fred W. Jobe at the Bausch & Lomb plant.

THE RELATIONSHIP BETWEEN REFRACTIVE STATE OF THE EYE AND INTELLIGENCE TEST SCORES*

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Numerous writers have suggested that there is some degree of association between refractive state of the eye and intelligence, the myope usually being said to possess the higher intelligence and the hypermetrope, the lower. The evidence has usually been based upon observation of a few patients with extreme ametropia or with marked deviations from the average intelligence or upon clinical impressions. Thus, information on the degree of relationship or the presence of association among those who deviate only moderately from the mean with regard to either variable is lacking.

In the present study the refractive state and the intelligence test scores of 554 randomly selected school children are analyzed. These children, whose ages ranged from six to seventeen years, were enrolled in the public schools at Worthington, Ohio, in 1947-48 when the present study was conducted.

HISTORICAL CONSIDERATIONS

Studies conducted in the past will first be reviewed. In general, the evidence falls into one of four general categories.

(a) *Association between high hypermetropia and low intelligence.* There seems to be a good relationship between high hypermetropia and low intelligence, especially in so far as extreme hypermetropia associated with microphthalmos is concerned. The following case reports may be summarized: Harmon[1a] reported an 18.00 D. hypermetrope who was feeble-minded: Lafon[1b] reported a 15.00 D.

*The present study was conducted during the Academic year 1947-1948 while the author was an assistant professor at the Ohio State University School of Optometry. A report of these data was given at the Annual Meeting of the American Academy of Optometry in Winston-Salem, North Carolina, in December of 1948. While the data were not complex and the statistical evidence was simple and straightforward, the interpretation of the results was far from clear. The author withdrew the paper from publication to allow himself to think about the possible meaning of these results. Now, ten years later, the meaning is still not completely clear, but these results along with possible interpretations are being published so that others may use them and possibly interpret them better. Since this study was made, an attempt was made by Melvin Nadell and the present author to substantiate these findings, and this study appeared in the June, 1958, issue of this publication. Submitted on May 20, 1958, for publication in the January, 1959, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

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hypermetrope with microphthalmos and feeble-mindedness: Stieren,[1c] a similar patient with 21.00 D. of hypermetropia: Chavasse[1d] ,a similar patient with 18.00 D. of hypermetropia: and Clausen,[1e] a patient with feeble-mindedness, microphthalmos, and 15.00 D. of hypermetropia. This syndrome of sex-linked microphthalmos and hypermetropia and mental deficiency was discussed by Roberts.[2] The subject was reviewed by Pfingst[1] from whose study the above mentioned references were obtained.

This syndrome, characterized by the arrested development of several structures, was understood and described by Donders.[3] Unlike those who classified hypermetropia as low, medium, or high solely on the basis of the degree of ametropia, Donders based his classification upon the presence of other signs of arrested development and especially upon the presence of facial stigmata. A number of physical signs associated with microphthalmos have been noted: Yudkin,[4] for example, described a patient with malformation of the heart, presence of supernumerary fingers, and microphthalmos. Duke-Elder[5] pointed out that patients with unilateral microphthalmos show an underdevelopment of the face or even the entire body on the same side as the microphthalmos. He also noted that a frequently observed defect in patients with microphthalmos is cerebral deformity (micrencephaly, encephalocele) and idiocy. The numerous references cited by Duke-Elder need not be repeated here.

There seems to be no question but that microphthalmos is usually accompanied by other signs of arrested development, feeble-mindedness being one of these. As a result, a small group of patients with extreme degrees of hypermetropia and feeble-mindedness is encountered. It should be pointed out, however, that microphthalmos is not invariably associated with hypermetropia. Duke-Elder[5] cites six authors who found high myopia, one of 20.00 D. associated with microphthalmos. Nor is feeble-mindedness limited to hypermetropia: Kalt,[6] for example, has described a mentally deficient two year old with myopia of 12.00 D. in one eye and 18.00 D. in the other. Finally, it must be realized that while microphthalmos and the consequent high hypermetropia may well be due to an underdeveloped globe, there is no basis for assuming that moderate degrees of hypermetropia represent lesser degree underdevelopment. The cause or causes of high hypermetropia and of moderate hypermetropia may be very different just as shortness of stature is genetically determined while dwarfism with its associated and extreme shortness rests upon a hormonal basis.

(b) *Association between moderate degree of hypermetropia and*

low intelligence. There is less evidence for association between moderate hypermetropia and some reduction in intellignce, but such claims have been made. Stocker[7] observed that there was a greater percentage of hypermetropia, convergent squint, and amblyopia among the inmates of a home for subnormal children than among a similar group of normal children. This was true not alone for the extremes, Stocker claiming that the average degree of hypermetropia paralleled the degree of mental deficiency. Kurz[8] observed that among the inmates of two institutions for the feeble-minded, the proportion of moderate and high hypermetropes was considerably in excess of that found among normal subjects of the same ages.

It should be noted that while moderate degrees of hypermetropia are considered in the two papers just cited, the low intelligence is extreme. No evidence has been encountered for association between moderate hypermetropia and slightly below average intelligence.

(c) *Association between myopia and "intellectual" occupations.* A number of investigators have noted a higher percentage of myopes in the so-called "intellectual" occupations than in "non-intellectual" pursuits. This fact has been mentioned by Tscherning,[9] Segal,[10] Birnbaum,[11] and Heinonen[12] among others. The last mentioned author on the basis of such observations states that myopia is correlated with the intellectual endowment of the individual. That such evidence must be regarded with extreme caution is clear. There are many factors other than refractive state or intelligence which enter into the selection of an occupation.

Even if we assume that a real relationship between myopia and intellectual work exists, other difficulties arise. Two opposing hypotheses may be advanced to explain such a relationship. The first is that persons with greater intelligence over-use or misuse their eyes and thus tend to develop myopia; the second that myopes are better fitted for occupations involving near work and enter such callings by choice. The first hypothesis stems from Cohn,[13] while the latter has been championed by Ochapovsky[14] and other recent workers. However poor the evidence, it may be noted here that the presence of large numbers of myopes in "intellectual" occupations has been used as evidence of the association of myopia with intelligence.

(d) *Developmental basis for association between myopia and high intelligence.* The myopic eye has been considered by various authors as particularly adapted to civilized life. Landolt,[15] for example, in his discussion of refractive error states, "If hyperopia represents an arrest of development, typical myopia may be considered as a state created

by nature with the aim of adapting the organ to the functions of a superior race." Steiger evidently held similar views, for von Moers-Messmer[16] in reviewing the theories which have been proposed to explain the development of myopia states that he agrees with the findings of Steiger that myopia is usually associated with high intelligence. His further speculative conclusion is that the development of the brain may affect the length of the eyeball. Roy[17] also held similar views, stating that "the vision of different people is proportionate to their intellectual development . . . the higher the human being rises in the social scale, the more the brain develops at the expense of the organs of sense, chiefly of vision and hearing."

* * * * *

Summarizing the historical considerations, it is seen that the evidence for relationship between refractive state and intelligence arises from four different types of observation. Only one study was encountered in which intelligence and refraction were actually measured on a random sample of the population. This one by Goodsell,[18] however, suffers from a small sample and a poor statistical design of the experiment, and these lacks make it impossible to draw any conclusions from this work.

The evidence thus far presented indicates that high hypermetropia (microphthalmos) is frequently associated with feeble-mindedness: an arrested development of eye, brain, and other structures probably underlying the relationship. There is some evidence also for the association of moderate hypermetropia with feeble-mindedness. There seem to be no studies involving those with intelligence slightly above or below the average. Myopia is claimed to be associated with higher intelligence, the arguments stemming from occupational choice and from speculation on the common embryological origin of brain and eye (retina). Either of these arguments may or may not be valid, and both lack experimental substantiation.

It should be mentioned that a definition of intelligence is not usually given in the papers reviewed, many of these having preceded the intelligence test: the criterion of intelligence is, therefore, frequently far from clear. For the present investigation, an operational definition will be used, intelligence being that characteristic which is measured by intelligence tests, and more specifically by the test used in this study.

PRESENT INVESTIGATION.

During a school vision survey at the Worthington (Ohio) grammar and high schools, 554 white school children aged six to seventeen years were examined. The refractive state was determined retinoscopi-

cally for the horizontal meridian of the right eye only, using the author's method described in another paper.[19] While a single meridian of one eye is not an ideal measure of refraction, it is nonetheless a usable measure and has some advantages over the more usual equivalent sphere. Since high astigmatism and anisometropia are the exceptions rather than the rule, no systematic error should result from the use of this measure.

At the time of the visual examination a comparison of refractive state and intelligence was not contemplated. However, independently, intelligence tests had been administered to this same group within the past year by the school psychologist and this material was made available to the author.*

The intelligence tests which had been administered to these children were the Stanford-Binet for the lower two grades (mainly six and seven year olds) and the California Test for Mental Maturity (for the remainder of the children). The former test is administered to children individually, while the latter is a group test. Certain features of this latter test should be reviewed. Since it is a group test, speed is one of the requisites for obtaining a high score. The test items, especially in the advanced forms of the test used for the older children, require a good deal of fine visual perception of detail. In one portion, for example, a series of small line cuts, approximately one inch square, with fine detail and reasonable complexity are compared, the task being to select the picture that is different from the others in the group. Since rapid perception of fine detail is required to score high in this part of the test, any generalization regarding correlation between the refractive state of the visual apparatus and the intelligence test score must be interpreted with this in mind.

Consequently, the basic data for the present investigation consist of the I. Q. score, the skiametric estimate of the refractive state, and the age for each of the 554 school children. The two sets of observations, I. Q. and refractive state, were made independently by different observers but within the same year of age.

RESULTS

The correlation coefficients for the 554 children were as follows:

Between age and refractive state	—0.18	$P = <0.001$
Between refractive state and I. Q.	—0.19	$P = <0.001$
Between age and I. Q.	—0.01	not significant

The first order partial correlation coefficients did not differ markedly from the zero order coefficients presented. The absence of

*The author expresses to Mrs. Tyler, the school psychologist at Worthington, who did all the intelligence testing and made her data available for this study, his sincere appreciation. Without this cooperation this present study could not have been made.

correlation between age and intelligence test score is to be expected, as is the negative correlation between age and refraction, the minus sign indicating a tendency toward less hypermetropia or more myopia with increased age. The equally high and significant coefficient for refraction and intelligence test score is worthy of note. The negative sign indicates a tendency for higher intelligence test scores associated with minus refraction or myopia and lower intelligence test scores associated with hypermetropia.

Another method of analysis consists of dividing the data into three age groups: (A) those between six and nine; (B) those between ten and thirteen; and (C) those between fourteen and seventeen. For each age group, the mean and standard deviation for refractive state and for I. Q. were determined, and also the coefficient of correlation between refractive state and I. Q., along with the probabilities that such coefficients could have been obtained by chance in a population in which no correlation existed. These results are presented in Table I.

TABLE I

Relationship between refractive state and I. Q. for various age groups

Group	Age Range	Number of Cases	Mean Refractive State	Standard Deviation of Refractive State	Mean I. Q.	Standard Deviation of I. Q.	Correlation Coefficient	Probability
A	6- 9	180	+1.01	0.79	111	14	—0.04	*
B	10-13	177	+0.78	1.19	110	15	—0.21	0.01
C	14-17	197	+0.48	1.56	113	17	—0.24	0.001

*Not significant.

The average refractive state, as might have been predicted, changes in the direction of less hypermetropia with increasing age, and, as also might have been expected, the standard deviation of the refractive state increases with age. There is not any marked or systematic change in I. Q. with age, nor would such a change have been anticipated. The average I. Q. is somewhat higher than the "normal" of 100, and this, also, is not uncommon in a public school group. It is the correlation coefficients that are most interesting. The coefficient for group A is very low and could have occurred by chance; that for group B is higher and could have occurred by chance only once in one hundred; and that for group C is higher yet, the significance level being one in one thousand.

One other fact which might be interesting is to know whether the correlation present in the oldest age group was due to higher intelligence among the myopes, lower than average intelligence among the hypermetropes, or both. The 197 cases in group C were divided into five groups according to refractive error, and the average I. Q. for each of these groups was determined. These data are presented in Table II.

TABLE II

Average I. Q. for various refractive states (ages 14 - 17)

Refractive Error	Number of Cases	Average I. Q.
More than 2.00 D. hypermetropia	14	106
Between 1.00 and 1.75 D. hypermetropia	58	109
Between emmetropia and 0.75 D. hypermetropia	87	116
Between 0.25 and 1.75 D. myopia	24	119
More than 2.00 D. myopia	14	123
Total	197	113

The small total number of cases and especially the presence of only fourteen cases at either extreme leaves much to be desired. However, the orderliness of the increase of average I. Q. with refractive power makes the data interesting: the conclusion may be drawn without further statistical analysis that the hypermetropes have an average I. Q. below the mean of 113 for the entire group, while the myopes have an average value considerably above this.

DISCUSSION

The mechanism or mechanisms responsible for the relationship between intelligence test scores and refractive state is far from clear. Four hypotheses may, however, be examined briefly.

(a) The first possibility is that claimed by earlier authors and already cited: namely, that myopia is an overdevelopment of the eye just as hypermetropia is an underdevelopment, and that ocular and cerebral development are related. If this were true, however, one would expect to find a relationship between the two variables among the younger children. That there is no correlation within this group seems sufficient reason for rejecting this hypothesis.

(b) A second possibility is that intelligence test scores are to some degree influenced by the amount of reading which a child does. The myopic child, better adapted for reading than for playing games, might do more reading and, hence, obtain a better intelligence test score: the hypermetropic child, on the other hand, handicapped to some degree in reading, might read less, and, hence, make a lower score. The objection to this hypothesis is that intelligence test scores are asserted to be not influenced by study or reading. Further, there is an absence of proof that myopic children do in fact read much more than hypermetropic children.

(c) The third possibility is similar to the second except that intelligence rather than refraction might determine the amount of reading done. Thus the more intelligent child might read more and, due to constant application to the near task, might become myopic. The less intelligent child, on the other hand, might read less and, hence, avoid becoming myopic. The obvious weakness for such an hypothesis is the absence of established evidence for use of the eyes influencing refraction and producing myopia.

(d) The fourth possibility has already been suggested in the discussion of the intelligence tests used here. In taking the test, the child is required to perceive fine detail, and a premium is placed upon his ability to do so at a rapid rate and for a prolonged period of time. The hypermetropic child, maintaining accommodation with difficulty, is certainly at a disadvantage, just as the myopic child, requiring little or no accommodation, will be ideally situated to perform well in this test situation. It may be argued that these children probably will be wearing lenses and that this difference will not be as marked as one might believe. On the other hand, our experience in school vision work leads us to the conclusion that to a major extent the hypermetropic child whose degree of hypermetropia is not great enough to produce an accommodative squint is frequently not wearing spectacles. On the other hand, a random sample of myopic children will show a great number uncorrected or undercorrected. This is due to the facts that moderately low degrees of myopia are not quickly discovered or corrected, that myopia frequently increased since the lenses were prescribed, and, finally, that many ophthalmic practitioners believe in undercorrecting myopes. In fact, oddly enough, many who believe in undercorrecting myopia also believe in undercorrecting hypermetropia. This same phenomenon will enhance the performances of the myopes on a paper and pencil speed test and handicap the hypermetrope.

Of the four possibilities the last seems to us to be the most probable. That correlation was absent in the youngest group might well be due to the fact that many of these children received the Stanford-Binet test which does not place a premium on rapid and sustained perception. This suggests a further study which should be made. The same group of older children should be given the California Test for Mental Maturity as well as an individual test similar to the Stanford-Binet. If, now, the correlation between refraction and test score is higher for the California Test for Mental Maturity than for the other test, then the above mentioned explanation is probably correct.

In discussing these hypotheses, we must not lose sight of the fact

that, whatever the case, the relationship is not a very strong one and has little predictive value. The highest coefficient obtained was —0.24 which, when squared, is about 0.06. Thus, we may say that about six per cent of the variability in intelligence test scores is associated with variation in refraction. We must also note that for this small degree of association at least four hypotheses must be considered as possible explanations: while one of these seems best to the author, all may contribute, and we must realize that the degree of relationship due to any one cannot be great. It must be concluded that in searching for the etiology of refraction and refractive errors, data like these contribute little to the overall picture. Furthermore and most emphatically, on the basis of a visual examination, a child's intelligence cannot be predicted nor can his refractive state be predicted on the basis of his score on an intelligence test.

OJAI, CALIFORNIA

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ANNOUNCEMENT

A.O.A. POST-GRADUATE INSTITUTE AT BALTIMORE

The first American Optometric Association Post-Graduate Institute is scheduled for April 5-6 at the Hotel Sheraton Belvedere, Baltimore. The subjects that will be featured are *Estate Planning, Doubling Your Income, Budget and Credit Systems, Making the Most Out of Patient Referrals* and *Handling the Child Patient.*

The Baltimore Institute is the start of a series of special optometric meetings designed by the A.O.A. to replace the Four Star Forums. At these meetings emphasis will be placed on elevating the economic status of optometrists.

Invitations to participate in the Baltimore Institute are being mailed to all A.O.A. members in the states of New York, New Jersey, Pennsylvania, Maryland, The District of Columbia, Virginia, Delaware and West Virginia. Any member of the association is welcome to attend. Similar meetings will be held in other parts of the country. The registration fee is $15.00. Registrations should be mailed to the American Optometric Association, 4030 Chouteau Avenue, St. Louis 10, Missouri.

PARTIAL CYCLOPLEGIA AND THE ACCOMMODATION-CONVERGENCE RELATIONSHIP*

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INTRODUCTION AND HISTORY

In his investigation of Donders' graph of the zone of clear single vision, Hofstetter[15] called attention to the convergence projection of the zone at the limit of accommodation. Figure 1. Because the haploscope used by Hofstetter was limited to a total of 45° of measurable

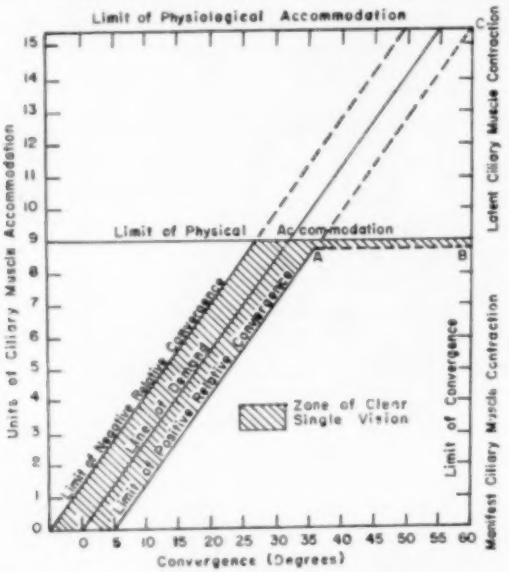
Limit of Physiological Accommodation
Limit of Physical Accommodation
Units of Ciliary Muscle Accommodation
Latent Ciliary Muscle Contraction
Manifest Ciliary Muscle Contraction
Limit of Convergence
Zone of Clear Single Vision
Limit of Negative Relative Convergence
Line of Zero Relative Convergence
Limit of Positive Relative Convergence
A
B
C
0 5 10 15 20 25 30 35 40 45 50 55 60
Convergence (Degrees)

Fig. 1. Diagrammatic representation of the hypothetical latent physiological accommodation range ($\overline{BC}$) and the projection of the zone of clear single vision ($\overline{AB}$).

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This paper was presented in partial fulfillment of the requirements for a B.Sc. in Optometry Degree with Distinction at the Ohio State University in 1952. It won for the author one of the two Bing Memorial Awards given in 1952 to the two seniors in the Ohio State University School of Optometry completing the best original studies related to visual perception.

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convergence, he was not able to investigate fully the characteristics of this projection.

This was undertaken by Alpern[2] on an instrument referred to as the "proximometer." The existence of the projection was verified at convergence levels exceeding 60°.

The presence of the projection can be accounted for in at least two ways:

1. As a manifestation of fusional convergence.
2. As a manifestation of accommodative-convergence.

The explanation of the projection seems to involve the question as to what relationship exists between ciliary muscle contraction and the changes in accommodation associated with increasing age. Regarding this problem, two opposing theories have been offered.[3]

1. The theory implied in the writings of Donders and Landolt, and which is supported by Duane[7] and Fincham[10], is that maximum ciliary contraction is required to produce maximum accommodation at any age.

2. The theory, originally proposed by Hess, that the same amount of ciliary contraction is required to produce a unit change in accommodation at all ages.

If this latter theory is true, there must exist a gradually increasing "latent physiological range" of ciliary muscle contraction which does not result in a manifestation of increased accommodation, which, in turn, by the theory of Fincham[10], results from the inability of the lens to increase its convexity as the tension on its capsule is diminished (Figure 1).

In general, three methods of demonstrating the "latent physiological range" of ciliary muscle contraction have been used, as outlined by Alpern.[3]

1. Experiment on a case of pathological, unilateral cycloplegia. Morgan and Harrigan[16] compared the ACA ratio, as measured when the affected eye was fixating, to the ACA ratio when the normal eye was fixating, in a 28 year old woman. Using the reasoning of Fleiringa and van der Hoeve,[11] the "latent physiological range" could be calculated. Since the extent of reduction of physical amplitude could be determined, and the change of ACA ratio could be compared, these two factors give an indication of the total physiological range of ciliary contraction, and thus, the "latent physiological range," which is unassociated with changes of convexity of the lens, could be calculated. Morgan and Harrigan showed a very small "latent physiological range," much less than the hypothesis would suggest for a person of this age.

2. Experiments on the zone of clear single vision (Figure 1). The original Donders' graph of the zone of clear vision shows increased convergence at the limits of accommodation, but Donders' method for measuring accommodation at the near point of convergence (he occluded one eye after the near point was determined) may have given results anomalous to those of later investigations.[13] Other studies, by Hofstetter[13] and Alpern,[2, 3] are referred to above. In this type of study it is impossible to establish firmly whether or not the projection is a function of accommodative convergence, forced by increased innervation resulting from ciliary effort, or a function of fusional convergence, which has been supplanted by accommodative convergence at sub-maximal accommodation levels.

3. Experiments with drugs. It has been realized for some time that if the physiological range of accommodation is greater than the physical amplitude of accommodation, drugs which produce a slight paralysis of the ciliary muscle, might produce an effect on the ciliary muscle and still not affect the physical amplitude of accommodation. Since the "latent physiological range" should gradually increase with age, this should be more easily demonstrated on adults than on children.

This was the basis of Fuchs[13] report, in which a drop of 2% euphthalmine caused a reduction of 4 diopters of amplitude in an 11 year old boy and no change in amplitude of a 38 year old man.

Duane[7] measured the elapse of time after instillation of homatropine until the onset of paralysis as manifest by a reduction in the amplitude of accommodation in 2,013 patients. He found that the time interval was shorter in older groups than in younger groups.

The results of the above two experiments are in direct conflict in explaining the "latent physiological range," both experiments are subject to criticism, and neither is critical to the question.

Flieringa and van der Hoeve[11] attempted to measure the paralysis of the ciliary muscle by comparing the ACA ratio under binocular partial cycloplegia to the normal ACA ratio. The slope of the line representing negative relative convergence limits in two subjects which were obtained before and during partial cycloplegia were compared, and the latent ciliary contraction range was demonstrated. However, recent attempts by Hofstetter and Alpern[3] to repeat the experiments of Flieringa and van der Hoeve on five subjects have failed to give the same results.

Goldmann and Aschmann[14] have recently reported an experiment designed to determine the extent of variation of the amplitude of ciliary muscle contraction with the variation of amplitude of accommodation.

A partial paralysis of the ciliary muscle of one eye with homatropine was made, and the amount of accommodation employed by each eye to fixate an object at various distances was measured by a complex method employing a split pupil. The ratio of the accommodation employed by the partially paralyzed eye to that used by the normal eye was found to be constant for various distances of fixation and was taken as the index of paralysis of the drugged eye. This was found to be less than the ratio of the amplitudes of accommodation of the two eyes. Goldmann and Aschmann concluded that the maximum limit of ciliary contraction always exceeded the amplitude of accommodation but again, not to the degree that would be expected from the hypothesis of the "latent physiologic[al] range" of ciliary contraction. Unfortunately, Goldmann and Aschmann apparently measured only up to 5 diopters of accommodation and approximately 17° of convergence. The critical experiment of this type would seem to be a measurement of the accommodation of the partially-paralyzed eye when the normal eye is exerting maximum effort.

If the same amount of ciliary muscle contraction is required to produce the maximum amplitude of accommodation at any age, a unit change in muscle contraction would produce less and less refractive change as the individual grows older. If the amplitude of total convergence is not effected by age, as shown by Duane,[8] the innervation to the convergence mechanism is probably constant throughout life. Since the innervation to accommodation and to convergence are probably interrelated by some central mechanism, these facts would indicate that the ACA ratio should increase with age. However, statistical surveys by Alpern and Hirsch[4] and by Morgan and Peters[17] of clinically determined ACA ratios show that this is not true, but in fact the ACA ratio seems to decrease slightly with age. These findings may be an artifact of the clinical method for measuring the ACA ratio, as pointed out by Alpern.[3] In clinical procedure the stimulus to accommodation, rather than the accommodative response, is considered. This permits the patient to use variable amounts of accommodation in response to a fixed stimulus to accommodation. The magnitude of discrepancy between the results becomes a function of the depth of focus of the eye. This entity must increase with age, since its primary factor is the size of the pupil, which decreases with age, according to Birren, Casperson and Botwinick.[6]

PURPOSE AND METHOD

It was the purpose of this investigation to study the characteristics of the projection of the zone of clear single vision at the limits of accom-

modation, with special attention upon establishing or disproving the contention that this projection is a manifestation of accommodative-convergence. The method used was a haploscopic investigation of the zone of clear single vision combined with the use of monocular partial cycloplegia.

APPARATUS

The method employed in this investigation made use of a modification of the mirror haploscope, which was previously employed by Fry,[12] in which convergence limits were extended to exceed 60° of total convergence and in which actual accommodation in each eye could be measured independently of the stimulus to that eye. The stimulus to accommodate could also be varied independently for each eye.

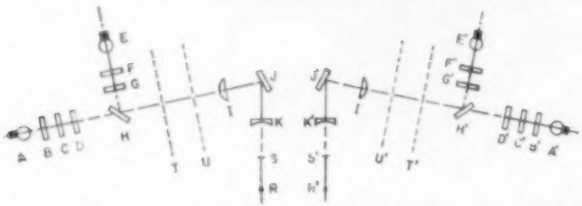

Fig. 2. Optical system of the haploscope used in this investigation (schematic).

Figure 2 illustrates the optical system for the apparatus. The two arms of the instrument were mirror images, except for the positioning of the slits of *D* and *D'* (vertical vs. horizontal). Therefore, a description of one arm will suffice for its opposite (denoted by corresponding, but primed letters). *A* was a standard 15 watt, 110 AC lamp, the electrical hook-up of which included a variable resistor, which enabled the intensity of this source to be reduced to threshold (just visible). This light illuminated a slit in a metal plate at *D*, after passing through a frosted glass diffuser at *B* and a red filter at *C*. The slit was calibrated optically to a size of 0.2 mm. (The slit on the right arm, *D'* was oriented horizontally, while that on the left, *D*, was oriented vertically.)

The source at *E* was a 7.5 watt lamp which illuminated a stimulus target, *G*, through the frosted glass diffuser, *F*. (*G* and *G'* were identical and are illustrated in Figure 3.)

At *H* was placed a front surface semi-silvered mirror. By this, *A* was seen simultaneously with *E*, the rays from which were reflected through an angle of 90° by the placement of the mirror, *H*.

Light from these two sources entered the optical system composed of a convex lens at *I* and a concave lens at *K*. The rays between *I* and *K* were reflected by a full front-silvered mirror at *J* through an angle

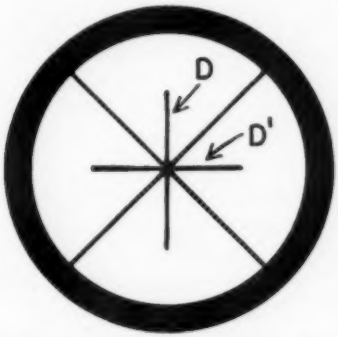

Fig. 3. Stimulus targets at G and G', shown as seen fused, with the superimposed lines (D and D') used to measure accommodation.

of 97.5°. The secondary focal point of the lens system composed of *I* and *K* was at *S*, 27mm. behind the secondary principle plane of *K*. This corresponded to the entrance pupil of the subject's eye. Thus the stimulus target underwent no change in angular size as it was moved fore and aft to provide a varying stimulus for accommodation.

R represents a point under the center of rotation of the eye in position. The arm of the haploscope rotated (symmetrically with the opposite arm, by virtue of the two arms being geared together) around a vertical axis through this point *R*.

The focal power of the lens system composed of *I* and *K* was 6.438. The optical separation is 10.29 cm. and the focal length 155mm. *T* represents the primary principle plane of the system: *U* represents the secondary principle plane.

The entire right arm (*A'* through *U'*) could be moved to adjust for variations of interpupiliary distance. Adjustments for differences in vertical phoria were made by rotating the housing carrying the lens system *I'* and *K'*. The target at *G'* was rotated to correct any observable variation in cyclo-phoria.

The stimulus to accommodation was created by moving the entire illuminating system, *A* through *H*, toward or away from *I*. The stimulus to each eye could be varied independently, with angular size remaining constant. The value of the stimulus is given by the formula.

$$\text{Stimulus to Accommodation} = \frac{1}{d - \frac{1}{\frac{1}{u} + F}}$$

in which F = the refracting power of the system = +6.438 D.,
u = the negative distance T to G, and
d = the distance U to the spectacle plane,
13mm. behind K = 138mm.

A stimulus to accommodation range of from —1.00 to +8.00 diopters could be used in the instrument.

When the rays leaving K and K' were correspondingly parallel to each other, that is to say, when the subjects' lines of sight were parallel, the angle between the arms of the haploscope was 195°. The arms could be turned symmetrically by means of a set of gears so that a convergence range of from 5° of divergence to 62° of convergence could be measured. This last amount was found to exceed the absolute convergence possible in most subjects.

The elements A to D could be moved independently of the setting of the rest of the illuminating and stimulus system, (E through H) to measure to approximately two diopters of accommodation, both above and below the stimulus setting of target G. This measurement of actual accommodation in play was accomplished by the following method:

The subject would adjust the intensity of the red slits (D and D') to "just visible," and then would move them back until they disappeared, then move them forward to first clear focus. Then he moved the slits forward until they disappeared and backward until first clear focus. By manipulating the intensity of A and A' while making these adjustments of focus, a range of about one-half diopter could be established for clear focus—beyond which, further movement either backward or forward threw the slit noticeably out of focus. For each recording, several measurements of accommodation response were made and averaged for the most probable value of actual accommodation in play. Accommodation measurements were made monocularly (horizontal slit in the field of right eye, vertical in the field of left eye) while observing the fused, binocular image of the stimulus targets G and G'. Then the focus of each slit was checked against the other and readjusted minutely if necessary.

The targets used to stimulate accommodation and fusion are pictured in Figure 3, and were placed at G and G', the two targets being identical. Each consisted of a black annulus and cross on a white field. While measuring his accommodation, the subject was instructed—and constantly reminded—to keep in clear focus on the cross lines of the stimulus target.

Appropriate scales were incorporated on the instrument to give proper measurements of convergence, stimulus to accommodation for each eye, and accommodation response in each eye.

PROCEDURE

In order to insure the selection of subjects who could demonstrate the ability to call accommodative-convergence into play at sub-maximal levels of accommodation, subjects were chosen who demonstrated this ability on a haploscopic charting of the zone of clear single binocular vision. The curves thus determined are shown in Figure 4. A projection

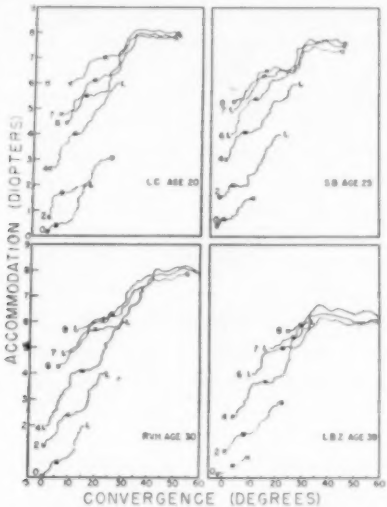

Fig. 4. Haploscopic plots of the zone of clear single vision. Crosses represent phoria positions. Squares represent break points. The symbol L indicates that the limit of the instrument was reached. The numbers indicate the stimulus to accommodation.

is manifest in each case at the limit of accommodation. The procedure for obtaining this type of curve is discussed by Hofstetter[15] and Alpern.[2]

Four subjects were used, each was a student of The Ohio State University School of Optometry who was able to make the careful judgments of a critical, experienced observer. During the experiment each subject wore his correction which made him equivalent to an emmetrope.

For each of these subjects a record was made in the following manner: (1) At successive diopter steps of stimulus to accommodation from zero to eight, the phoria position was determined by turning out the light source at E so that the stimulus target at G would not be seen. Thus, only the vertical red line was seen by the left eye. The subject kept in clear focus for the cross lines of the target at G' and the arms of the haploscope were adjusted so that the vertical red line was perceived as being through the center of the cross—and remained so upon

intermittent interruption of the vertical red line. (2) The source at *E* was again turned on and the subject adjusted the measuring device for each arm of the haploscope, thus measuring independently the accommodation in play for each eye at this phoria position: this procedure has been previously explained. (3) When the limit of the subject's ability to accommodate was established—or the limit of the stimulus apparatus (8 diopters) was reached, the stimulus was set at an arbitrary level *above* the amount of accommodation ability manifested by the subject in the procedure outlined. This was usually different for the two eyes. The haploscope arms were then adjusted to the maximum divergence which the subject could reach at this level of accommodation without breaking fusion. At this point, and at successive steps of 5° of convergence to the limit of total convergence possible by the subject or to the limit of the instrument (60°), a measure was made of the accommodation in play. The last few points of this set of measurements were along the projection of the zone of clear single binocular vision.

The above outlined procedure was first performed before the use of the drug, to establish a normal curve. Each subject then received two drops of 2% homatropine in his left eye, and the entire procedure outlined above was repeated at appropriate time intervals during the period in which the subject was recovering from his cycloplegia. No attempt was made to insure complete cycloplegia, since this was not important to the study. Successive sets of data were taken until the subject showed a return of all except about one diopter of accommodation. It was deemed unnecessary and unwarranted to continue, since it would have taken several hours for the last effects of the drug to disappear.

The results of these studies are shown in Figures 5 to 8, inclusive. In the figures, the solid curves indicate accommodation at the phoria positions; the broken lines show the accommodation at successive amounts of convergence with the stimulus to accommodation fixed. The open circles show the data for the right eye (normal eye); the solid circles show the data for the partially paralyzed left eye. Ordinates are accommodation measured in diopters, abscissae are convergence measured in degrees. See pages 34 and 35.

RESULTS

Homatropine is a synthetic compound which is chemically related to the alkaloids of the belladonna plants, but having a mandelic acid base instead of the naturally occurring troponic acid.[1] It acts on the ciliary muscle by depressing the activity of the para-sympathetic nerve endings, by paralyzing the myo-neural junction between the third nerve

and the ciliary and pupillo-sphincter muscle fibers.[9] Homatropine prevents the action of acetylcholine at the motor end plate: either it has a greater affinity for the motor end plate of the cell than does acetylcholine, or it depresses the motor end plate to an extent sufficient to inhibit stimulation of the muscle cell[1]. This inhibition raises the relative threshold for the transmission of a nerve impulse to the muscle fibers at the various myo-neural junctions in the ciliary muscle. If the amplitude of accommodation is not limited by the inability of the lens substance to change its convexity, any increase in innervation to accommodation should produce a resultant increase in accommodation in the eye which has been partially paralyzed by the presence of homatropine. The results of this investigation on the eyes in their normal undrugged status demonstrate the commonly accepted principle that accommodation is equal in the two eyes at any given moment. For each subject the deviation between the two eyes is within the range of experimental error, at each level of accommodation and with various degrees of convergence. This is a demonstration of the fact that innervation to both eyes is equal in the act of accommodation. Therefore, if one eye is increasingly forced to accommodate, to its limit, innervation to both eyes will be constant, and the opposite eye will show a continual increase even if it is partially paralyzed by the action of a drug such as homatropine. Of course, the response in the partially paralyzed eye will not be as great as normal, but it will be in constant ratio to the normal eye. This was verified experimentally by Goldmann and Aschmann[14] and is shown also in the sets of data represented in Figures 5, 6, 7 and 8. This investigation, therefore, confirms the findings of Goldmann and Aschmann: that the ratio of accommodation response of the partially paralyzed eye to that of the normal eye is constant "for various distances of fixation" (or in this case, for various stimuli to accommodation).

Since convergence and accommodation are linked together by some central mechanism, it can be reasoned that if convergence is forced to its limit, and if the responding convergence is of the accommodative convergence variety, then, innervation will be increasingly supplied to the accommodation mechanism of the eyes during this forced convergence. If one eye is under the partial paralysis of homatropine, it should respond to this type of stimulation by a continually increasing manifestation of accommodation response. The second set of data obtained in this investigation sets up exactly this set of conditions, but the results fail to show the increasing accommodation response of the partially paralyzed eye.

It seems apparent, therefore, from this investigation, that the projection of positive relative convergence at the upper limit of accommodation, which has been shown in the graph of the zone of clear, single vision, is not a manifestation of accommodative convergence.

It might be expected that the ratio of the measured amounts of accommodation in the two eyes might be affected by differences in the sizes of the pupils of the two eyes and the relation of spherical aberration to pupil size. Also the value used for the zero level of accommodation which is more or less arbitrarily chosen, might affect the measured ratio. These sources of experimental error, however, do not appear to be serious enough to affect the general trend of the data.

DISCUSSION

Convergence can be classified into the categories of accommodative convergence, fusional convergence and psychic convergence. When measured on the haploscope "awareness of nearness" is eliminated as a variable factor. Therefore, it is not probable that the projection of the zone of clear single vision is a result of psychic convergence in the ordinary sense. The results of this investigation show that it cannot be a manifestation of accommodative convergence. The only possible explanations which remain for the projection are that it is either fusional convergence or a classification of convergence which is additional or supplementary to those listed above.

One fact which was manifest by all subjects of this investigation, and which was also observed by Alpern,[2,3] seems to be positive evidence that the convergence projection is not a manifestation of fusional convergence. This fact is that the convergence along the projection was under the voluntary control of the subject. He could force himself to hold fusion, and indeed was obliged to do so at the last points which were measured. During the measurements at these last points, each subject reported the difficulty of holding fusion and the intermittent "pulling apart" of the observed images as he forced himself to keep single vision. Fusional convergence has always been thought of as being involuntarily induced.

There remains, therefore, only the explanation that the convergence projection which has been demonstrated at the upper levels of accommodation is a manifestation of some type of convergence not previously described, which, for lack of a better term, may be referred to as "voluntary" convergence.

If there exists a type of convergence which is under voluntary control, as this investigation seems to indicate, then it should be possible

to train this ability so that an extremely large range of positive relative convergence could be manifest at all levels of accommodation. The theoretical limit for base-out training would become the line determined by the binocular near point of convergence and the slope of the zone of clear single vision.

It is also possible, however, that a common center for innervation to both accommodation and convergence exists within the portion of the cortex controlling voluntary action (presumably the frontal area). Such a center would feed impulses simultaneously to accommodation and to convergence. Under these, the normal conditions, accommodation and convergence would exhibit the classical straight line relationship. However, when the portion of these impulses normally going to accommodation is blocked by some peripheral condition, such as an upper limit of discharge to the ciliary muscle, this portion of the innervation is switched to the convergence mechanism, augmenting its normal portion of the total innervation and thus producing an exaggerated convergence response at the maximum limit of accommodation.

The absence in some persons, as reported by Alpern,[2] of this projection of convergence may be explained in at least two ways, if voluntary convergence is a separate entity: (1) Those persons have already reached the ultimate of their base-out ability at all levels of accommodation, or (2) Those persons are not able to use or have not learned to use their "voluntary" convergence at any level of accommodation, including the maximum ability of accommodation that they can manifest.

Further study, directed toward extensive base-out training of selected subjects who can demonstrate a projection of convergence at the maximum limit of accommodation, possibly could establish which of these hypotheses is correct. If it could be shown that the positive relative convergence line of the Donders' graph could be moved out to include the binocular near point of convergence, eliminating the previously manifest projection of convergence, as a result of base-out training, then "voluntary convergence" must be a separate entity. However, if the projection persisted, and it could not be shown that positive relative convergence could be trained to the ultimate limit hypothesized above, then the common cortical center for voluntary accommodation *and* convergence may exist, along with a peripheral "switch over" system for the impulses as described above.

The viewpoint that the projection is not a function of accommodative convergence gives support to the theory that maximum ciliary muscle contraction is required for maximum accommodation at all ages.

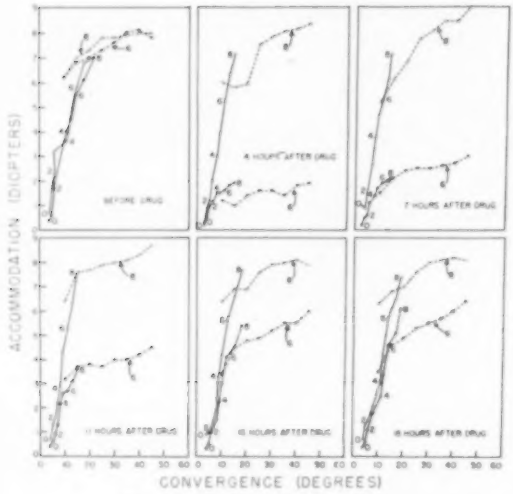

Fig. 5. Data for subject L.C.

The investigation of Goldmann and Aschmann[14] was similar to this investigation in many respects. Their finding, that the ratio of accommodation response of the two eyes is constant for all distances of fixation, was verified, for the most part, by the results of this experiment (as shown in Figures 5, 6, 7 and 8).

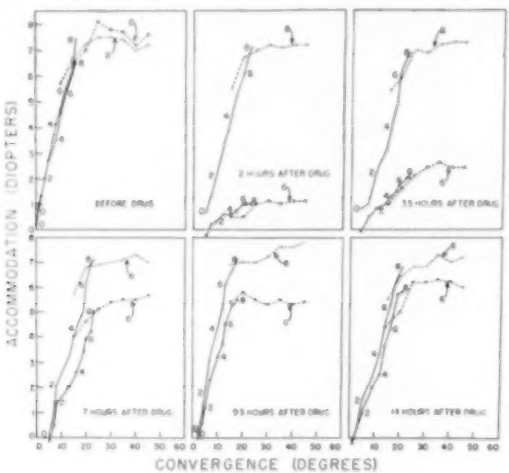

Fig. 6. Data for subject S.B.

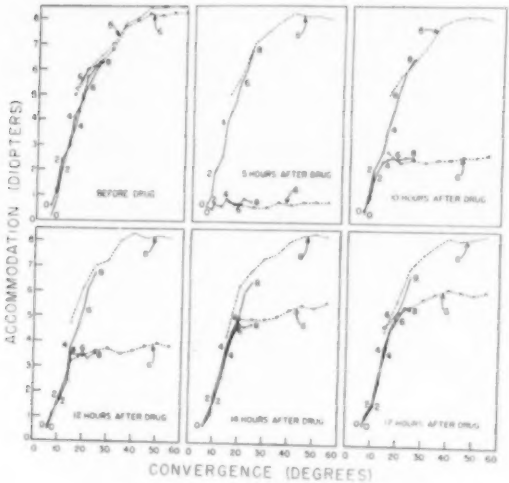

Fig. 7. Data for subject R.V.H.

The second finding of Goldmann and Aschmann, that the ratio of accommodation response of the two eyes for various distances of fixation was less than the ratio of the amplitudes of accommodation,

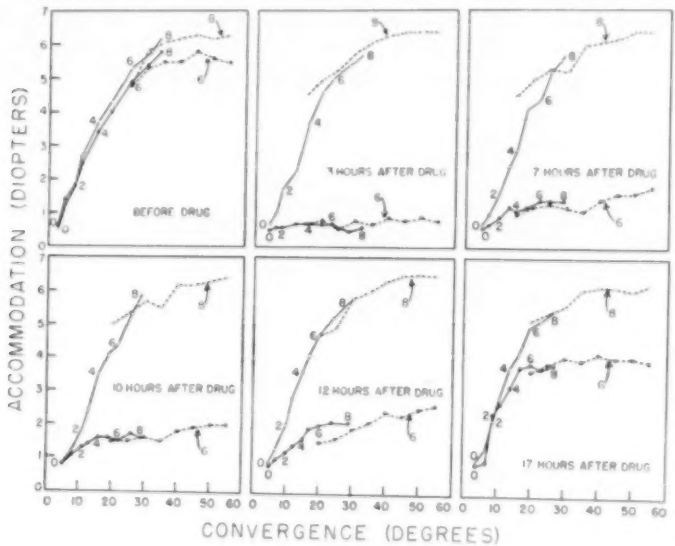

Fig. 8. Data for subject L.Z.

led to their conclusion that the limit of ciliary contraction always exceeded the amplitude of accommodation.

This second finding was not confirmed by the results of this investigation. In most cases, the two ratios were almost identical.

Since the second finding of Goldmann and Aschmann could not be confirmed, their conclusion, based upon this finding, must also be doubted. The results of this investigation show that the maximum limit of ciliary contraction does not exceed the amplitude of accommodation in all cases, but these two functions are probably about equal. This conclusion also supports the theory that maximum ciliary contraction is required for maximum accommodation at all ages.

This latter theory is also contested by the statistical studies by Alpern and Hirsch[4] and by Morgan and Peters,[17] in which it was found that the clinically determined ACA ratio does not increase with age. An interesting finding in this regard was also uncovered by this investigation. G. A. F., who served in preliminary experiments in this investigation, was also a subject for Hofstetter in his haploscopic study of the zone of clear single vision.[15] Hofstetter records a set of data which was taken on December 18, 1939, in exactly the same manner as the data shown in Figure 9, which was taken March 3, 1951, or eleven years, three and one-half months after the data of Hofstetter. Both sets of data were taken on a similarly operating haploscope, using similar stimulus targets and equivalent measuring devices. In the data presented by Hofstetter, the ACA ratio of the subject measures approx-

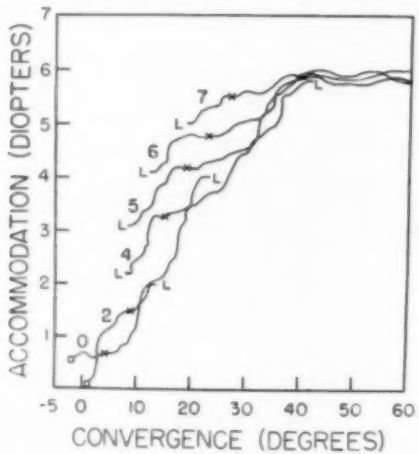

Fig. 9. The zone of clear single vision of G.A.F. showing an ACA ratio of 4.5 degrees of convergence per diopter of accommodation response.

imately 4.50 *centrads* per diopter of accommodation. In the present study G. A. F.'s ACA ratio as determined from Figure 9 was found to be 4.5 *degrees* per diopter *or approximately 7.8 centrads per diopter.*

The true picture of the age change of this function will not be known until haploscopic data have been collected on several subjects over a period of several years, as mentioned by Morgan and Peters.[17] However, here is evidence of at least one subject whose ACA ratio apparently has increased rather substantially over a period of eleven years.

Considerably variable rates of recovery time from the effects of the drug were met with as the collecting of data progressed. These are shown in Figure 10. Many explanations are possible, such as: loss of

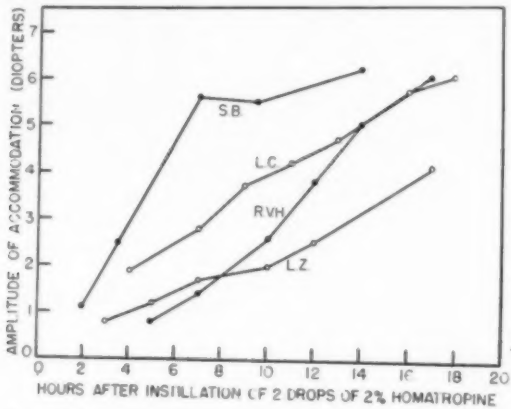

Fig. 10. The variable ratio of recovery time from the effects of two drops of 2% homatropine.

drug upon instillation due to excessive tearing, physiological variation in reaction time to the drug used, etc.

SUMMARY AND CONCLUSIONS

Data were collected at frequent time intervals while one eye was recovering from the effects of a cycloplegia resulting from two drops of 2% homatropine, as well as before the instillation of the drug. Haploscopic measurements of the accommodation response in both eyes were measured (a) at the phoria positions with the normal eye fixating, and (b) at increasingly greater amounts of convergence up to the limit of total convergence.

On the basis of these data, it may be concluded that:

1. Innervation to both eyes is equal in the act of accommodation.

2. The projection of convergence at the upper limit of accommodation, which has been characteristic of the zone of clear single vision of some subjects, is not a manifestation of accommodative convergence.

3. A type of convergence, not previously described, is necessary to account for this projection. It is some form of "voluntary" convergence. This may be an indication that the only theoretical limit of base-out training is the near point of convergence and the slope of the zone of clear single vision on the Donders' graph.

4. The ratio of accommodation response in the normal eye to that of the partially paralyzed eye is constant for various stimuli to accommodation. This ratio is approximately equal to the ratio of the amplitudes of accommodation of the two eyes, which indicates that the amplitude of ciliary muscle contraction is not always greater than the amplitude of accommodation.

5. By comparison of the data presented herein to that data of Hofstetter,[15] which was taken on a common subject, it was found that the ACA ratio of this subject has increased substantially over a period of eleven years.

6. Some minor variations in the data could possibly be eliminated by the repetition of the experiment utilizing a constant size, artificial pupil to minimize the effects of variations in spherical aberration.

7. This investigation tends to support the theory that maximum ciliary muscle contraction is required for maximum accommodation at all ages in three ways: (a) The convergence projection of the zone of clear single vision is shown not to be a manifestation of accommodative convergence. (b) The conclusion of Goldmann and Aschmann, that the limit of ciliary muscle contraction always exceeds the amplitude of accommodation, could not be substantiated by the data presented herein. (c) A case in which the ACA ratio has increased substantially over an eleven year period under carefully controlled experimental conditions is reported, throwing some doubt upon the statistical surveys which show that the ACA ratio tends to decrease with age.

8. Further investigation, directed toward extensive base-out training of subjects who demonstrate a convergence projection at the maximum limit of accommodation, might possibly establish the true innervational nature of the projection.

3425 S. DIVISION AVENUE
GRAND RAPIDS, MICHIGAN

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IN MEMORIAM

Anno Domini

1958

Dr. E. J. Cummins, Red Wing, Minnesota
Dr. W. J. Garrick, Los Angeles, California
Dr. John R. Hubbard, Cleveland, Ohio
Dr. L. Gerald Leonard, Minneapolis, Minnesota
Dr. Berne L. Pearl, Chicago, Illinois
Dr. Wallace H. Rozell, Chicago, Illinois

Since our last meeting, I regret to report that the Academy has lost six members through death. Each of these men played a significant part in the development of the profession, and each has left his important mark upon optometry. All have been active in the Academy. We miss these important leaders, and the membership of the Academy at this time pays tribute to their memory.

(From the minutes of the Boston, Massachusetts, meeting of the Academy.)

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A REPORT ON THE ACADEMY*

We are pleased to report progress in many avenues of Academy activity. This progress has been made possible by the fine leadership of President Tubesing and the work of many Committees, Chapters, and Sections. We have just completed a group of very well presented post-graduate courses and we are today starting another outstanding four-day educational program. During the year we have received many reports of excellent Chapter meetings in England, Canada and in the States. Three new Chapters were organized during 1958 and our members everywhere made important contributions to the literature. We have enjoyed a satisfactory and sound growth, and the membership is now at the all-time high point.

In its field the Academy is presenting to the profession from year to year a series of important optometric participation meetings entirely of educational character. We start one here today. In addition the

*Excerpts from the annual report of the Secretary, presented December 13, 1958, at Boston, Massachusetts.

Academy supervises a technical publication for all optometrists to read. This publication is also purchased and used in libraries and in educational centers from coast to coast. The Academy offers the profession well written and excellently printed short monographs at very low cost. More than 225 titles are now in stock and these are in constant demand.

Over the years the Academy has played an important role in publishing a number of books dealing with our science that have also found wide acceptance both in and out of optometry. The Academy has made many grants-in-aid for research purposes and will continue this activity. Its annual Post-Graduate Courses have now become an accepted part of noncampus graduate education in optometry and these courses are considered tops by all. This year, as our readers know, we have been making progress in developing what we hope will be the first of a series of fine and successful post-graduate homestudy courses for optometrists. Courses which will supplement in great detail the other aspects of Academy educational training for practicing optometrists.

In reviewing this successful program of post-graduate education for optometrists it is evident that there now remains another vital job to do. This is the setting up and financing of an accumulative index of all past and present optometric literature and keeping this index up to date. As a possible suggestion to our officers of the future, they may well consider utilizing the knowledge and skills of the editors and their associates who have just completed their task of getting out a new dictionary of visual science, and the possibility of subsidizing this group to make such an accumulative index possible under their immediate supervision. This would be a large and continuing task which should be given study by the Academy. If the project is found to be beyond our resources it is possible that we could get the American Optometric Association to help, as well as the Association of Schools and Colleges in Optometry, the American Optometric Foundation and the Optometric Extension Program. It is an important job which needs doing and all optometry would benefit by its establishment and continued development.

The Sheard Volume, in which the Academy played such an important part, has gotten off to an excellent start. This book is receiving wide acclaim, as we felt it would, and while its final cost was considerably more than expected there are indeed no regrets. It is a book that will long live in optometric circles and its value to the profession will become greater in the years to come.

During the year it was considered advisable to suggest an increase

in dues to the membership. This had been delayed for several years as the Executive Council had hoped the continued growth of the Academy would offset inevitable increases in operating costs. These increases were due to approved new projects, greater work loads and the unescapable inflationary trend. In the spring of 1958 it became evident that our small reserves were shrinking and it was decided to act. It is a tribute to the leadership of the Academy that without resorting to the "hard-sell" the ballots received from members were 3 to 1 in favor of the increase. On behalf of the Executive Council I wish to thank our membership for this vote of confidence and the needed additional financial support this brings.

Last October we joined other national optometric publications in pointing up the patient need for multiple spectacles and the opportunity this afforded optometrists in doing a better job of serving their patients and at the same time increasing their incomes. While this is somewhat outside of the normal field of Academy activity, we did so because it has become evident that the incomes of many optometrists are below the point they should be, and that optometrists everywhere were passing up the opportunity for greater service and greater income. An opportunity that should be implemented to the fullest.

From time to time Interprofessional Relations have been touched upon in these annual reports. There is now evidence that the whirlwind of criticism of our profession brought about by the organizational mistakes of 1953 and 1954 are beginning to subside. This is due in part to the now more conciliatory attitude of present A.O.A. leaders towards medicine and the assurance given medical leaders that optometry is not planning to enter the field of medical eye care.

Since our last meeting at Chicago, membership certificates have been issued to 66 optometrists, educators and scientists. On December 4, 1958, the membership of the Academy numbered 848. This is the high point in Academy membership. In addition, there are 90 active applicants in the hands of our committee on admittance.

In June of 1959 the American Optometric Association will hold its annual Congress in Dallas, Texas. Under all probability our Texas Chapter will be host at the regular Academy luncheon held during this meeting. Academy members are urged to attend the A.O.A. Congress. It is gratifying to note that so many Academy men are serving on the official team of the A.O.A.

Our 1959 meeting will be held December 12th, 13th, 14th and 15th at the Drake Hotel in Chicago. Our post-graduate courses will precede the annual meeting of the Academy on December 9th, 10th and

11th. Members are urged to start their planning to attend this meeting. Our committees are already at work to make these sessions as fine as possible.

CAREL C. KOCH

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

ACADEMY HOLDS SUCCESSFUL BOSTON MEETING

The attendance at the annual meeting of the American Academy of Optometry, Boston, December 10-16 was excellent, in spite of the strike that grounded many eastern air lines and the heavy snowfall that blanketed most of New England. More than 500 optometrists took part in the week's activities and Academy officers received many compliments on the splendid program and arrangements.

LAWRENCE FITCH ELECTED PRESIDENT*

Dr. Lawrence Fitch, 45, dean, Pennsylvania State College of Optometry, Philadelphia, was elected president of the Academy at the Boston meeting. He takes the place of Dr. Robert W. Tubesing who served during the past two years. Dr. Fitch was born in Philadelphia, May 17, 1913. He is the son of Dr. Albert Fitch, the founder of the Pennsylvania State College of Optometry and now its president and an honorary life member of the Academy. Dr. Lawrence Fitch is married to Adaline Nale. They have three children, Donald 17, Christine 12 and William 5. Dr. Lawrence Fitch received his B.A. degree at Temple University and his O.D. degree at the Pennsylvania State College of Optometry.

Dr. Fitch is a member of the Council on Optometric Education of the American Optometric Association; the board of directors of the Pennsylvania Optometric Association; a Fellow of the American Association for the Advancement of Science; a member of the Eastern Association of College Deans; a member of the American Higher Education Association and editor of the ALUMNI BULLETIN OF THE PENNSYLVANIA STATE COLLEGE OF OPTOMETRY.

In addition to his duties as dean of the college Dr. Fitch is also

*See frontispiece.

in private practice in Newtown, Pennsylvania, where Dr. Maybeth Brown serves as his associate. He is also past-president of the Council Rock School Board, Bucks County, Pennsylvania.

In commenting on his new position Dr. Fitch said, "I have three major objectives, (1) to continue the present fine educational programs of the Academy, (2) to get the now approved Program of Home Study courses into operation and (3) to bring the Academy membership up to one thousand active members."

Other officers elected at the annual meeting were Dr. Ralph E. Wick, Rapid City, South Dakota, vice-president, and Dr. Carel C. Koch, Minneapolis, secretary-treasurer. Dr. Robert W. Tubesing, Richmond, Indiana, will serve as past-president on the Executive Council which will consist of the officers and the following elected members: Dr. Donald A. Springer, Anniston, Alabama; Dr. J. Donald Kratz, Souderton, Pennsylvania; Dr. Monroe J. Hirsch, Ojai, California, and Dr. Edward J. Fisher, dean, Ontario College of Optometry, Toronto, Canada.

Dr. Rudolph Ehrenberg, Granite Falls, Minnesota, was appointed administrative assistant to the Executive Council.

The following appointive officers will serve ex-officio as members of the Executive Council: Dr. V. J. Ellerbrock, School of Optometry, The Ohio State University, Columbus, Chairman of Education, Academy Post-Graduate Courses; Dr. Henry W. Hofstetter, Division of Optometry, Indiana University, Bloomington, Academy representative, AAAS Council; Dr. Meredith W. Morgan, School of Optometry, University of California, Berkeley, Chairman of Education, Academy Home Study Courses; Dr. John D. Perry, Winston-Salem, North Carolina, Chairman, Academy Editorial Council, and Dr. Harold Simmerman, Wenonah, New Jersey, Chairman, Academy Committee on Admittance. Dr. Springer, in addition to his duties as member of the Executive Council, will serve as chairman of the Papers and Program Committee for 1959. He will be assisted by Dr. John Zettel, Jr., Cincinnati, Ohio; Dr. G. W. Clay, Ardmore, Oklahoma, and Dr. Alfred A. Rosenbloom, dean, Illinois College of Optometry, Chicago.

THE EXECUTIVE COUNCIL

At the meeting of the Executive Council at Boston several important actions were taken. These were:

- The nomination and election of Dr. Ralph Minor of Berkeley, California, to receive the Honorary Life Fellowship Award of the American Academy of Optometry at the 1959 annual meeting of the Academy, December 9-15, in Chicago. This award was voted Dr. Minor for his splendid work in helping develop the School of Optome-

try, University of California, Berkeley.

● Approved the plans and program for Academy Post-Graduate Courses to be given December 9-11, 1959, at the Drake Hotel, Chicago.

● Reviewed and reiterated their opposition to fee splitting among optometrists in the referral of contact lens patients.

● Considered and appointed a committee to study and report on the advisability of having Student Memberships in the American Academy of Optometry. This special Committee will consist of Dr. Gordon G. Heath, Bloomington, Indiana, chairman; Dr. J. Donald Kratz, Souderton, Pennsylvania, and Dr. Monroe J. Hirsch, Ojai, California.

● Studied and rejected the proposals to permit members and others to make tape recordings of post-graduate course material and papers presented before the general sessions of the Academy and its Sections.

● Received and approved the recommendations of the Charles F. Prentice Memorial Award Committee of the Academy and appointed a standing committee to make nominations for this award. The first award will be presented in 1960.

SECTION MEETINGS

The five Academy Sections met on December 14, 15 and 16. Each Section meeting lasted two hours on each of these days. The purpose of these meetings was to bring together specialists to discuss mutual problems arising within each specialty. These Section meetings were open to all members and guests. At all of these meetings the clinical side of optometric practice was stressed. The programs of the Sections at Boston follow:

SECTION ON ORTHOPTICS

Dr. John Zettel, Cincinnati, Ohio, Chairman.

Sunday, December 14. 9:00 A.M. - 11:00 A.M.

1. A Summary of Bangerter's Amblyopiehandlung. Dr. Meredith W. Morgan, School of Optometry, University of California, Berkeley.
2. Criteria for Success in Orthoptics. Dr. Frederick W. Hebbard, School of Optometry, The Ohio State University, Columbus.
3. Possible Visual Training Help with Cases of Low Negative Fusional Reserve. Dr. J. Donald Kratz, Souderton, Pennsylvania.
4. The Role of the Dynascope in Visual Training. Dr. O. R. Engelmann, Chicago.

Monday, December 15. 9:00 A.M. - 11:00 A.M.

1. Spontaneous Drawing as a Visual Diagnostic Aid. Dr. Leo A. Manas, Illinois College of Optometry, Chicago.
2. The Use of the Functional Readiness Questionnaire in Office Practice. Dr. Harold Solan, New York City.
3. Some Problems in Visual Training with Children. Dr. Lois Bing, Shaker Heights, Ohio.
4. Graphic Analysis Applied to Visual Training. Dr. Gordon G. Heath, Division of Optometry, Indiana University, Bloomington, Indiana.

Tuesday, December 16. 9:00 A.M. - 11:00 A.M.

1. Training Visual Retention. Dr. Louis Anapole, Boston.
2. Clinical Aspects of Anomalous Retinal Correspondence. Dr. Mitchell Kuhn, Massachusetts College of Optometry, Boston.
3. The Mark Diplopia Field Test. Dr. Marshall Mark, Massachusetts College of Optometry, Boston.

SECTION ON PATHOLOGY

Dr. Monroe J. Hirsch, Ojai, California, Chairman.

Sunday, December 14

9:00-11:00 Optometry and Interprofessional Relations. Dr. Carel C. Koch, Minneapolis.
Discussion by members of A.A.O. Executive Council.
A Special Invitational Report, Part II, of a series commenced last year.

Monday, December 15

9:00-10:30 A Home Study Course in Glaucoma. A report. Dr. Arthur Shlaifer, Philadelphia.

10:30-11:00 Color Vision Deficiency—Definition and Evaluation. A Color Training Film.
Commander R. L. Vasa, National Naval Medical Center, Bethesda, Maryland.

Tuesday, December 16

9:00- 9:45 The Lieb Anterior Chamber Lens. Dr. Richard Feinberg, Titmus Optical Company, Petersburg, Virginia.

9:45-10:30 Photography Used to Advantage in Office for Pathology Record. Dr. Alfred I. Aron, Houston.

10:30-11:00 Demonstration of a New Black Light Vision Field Testing Device. Dr. Monroe J. Hirsch, Ojai, California.

SECTION ON OCCUPATIONAL VISION

Dr. Herman Sager, Sperry Gyroscope Company, Lake Success, New York, Chairman.

Sunday, December 14, 9:00 - 11:00 A.M.

1. Round table discussion—"The Integration of a Visual Efficiency and Eye Safety Program with Prepaid Vision Services."
   Dr. Henry Peters, professor of optometry, University of California, Oakland, California.
   Dr. Alden Haffner, director, Optometric Center, New York City.
   Dr. Henry Hofstetter, dean, Division of Optometry, Indiana University, Bloomington, Indiana.
   Dr. Richard Feinberg, Director of Applied Research, Titmus Optical Company, Petersburg, Virginia.
   Mr. William Cameron, Industrial Vision Consultant, Thompson, Connecticut.
   Dr. Calvin A. Wood, Chairman, Occupational Vision Committee, American Optometric Association, Reading, Massachusetts.
   Dr. Herman Sager, Eye Service Supervisor, Sperry Gyroscope Company, Lake Success, New York.

Monday, December 15, 9:00 - 11:00 A.M.

2. (a) Terminology and Units of Measurements in Lighting. Dr. Sylvester Guth, General Electric Company, Cleveland, Ohio.
   (b) Reliability and Validity of Visual Acuity Testing by means of the Landolt Rings. Dr. R. A. Sherman, Titmus Optical Company, Petersburg, Virginia.

Tuesday, December 16, 9:00 - 11:00 A.M.

3. Session to be devoted to general discussion on the various existent problems, new ideas and future outlook for the development of the field of Occupational Optometry. Leading the discussion will be Dr. George C. Hill, Industrial Optometrist of the Norfolk Naval Shipyard.

SECTION ON ANISEIKONIA AND REFRACTIVE ERRORS

Dr. Oscar L. McCulloch, Holyoke, Massachusetts, Chairman.

Sunday, December 14, 1958

9:00 A.M. Refraction in Cases of Ciliary Spasm. Dr. Marshall Mark, Head of Orthoptics Clinic, New England Medical Center; Clinical Optometry Editor "Optometric World"; Associate in Optometry, Massachusetts College of Optometry; refractionist Massachusetts Memorial Hospitals and Massachusetts Eye & Ear Infirmary.

Monday, December 15, 1958

9:00 A.M. Measuring the Declination Error with the Standard Vernier Target. Dr. Samuel Swartz, Plymouth, Massachusetts.

Tuesday, December 16, 1958

9:00 A.M. Annual Round Table Discussion. Case Histories. Economics and Practice Management.

SECTION ON CONTACT LENSES AND SUBNORMAL VISION

Dr. Bernard Mazow, Houston, Texas, Chairman.

Sunday, December 14. 9:00 A.M. - 11:00 A.M.

Bifocal Contact Lenses. Dr. George Jessen, Chicago, Illinois.

A New Bifocal Microscopic Lens. Dr. William Feinbloom, New York City.

Monday, December 15. 9:00 A.M. - 11:00 A.M.

Comments on Micro-Contact Lenses with Case Reports on Fitting Children. Dr. I. Irving Vics, Albany, New York.

Corneal Contour—A Clinical Evaluation. Dr. Harold I. Moss, Wilmington, Delaware.

Tuesday, December 16. 9:00 A.M. - 11:00 A.M.

Refinements in Contact Lens Adjusting to Increase Wearing Time. Dr. Frederick H. Farnum, Boston, Mass.

MEETINGS

All but one of the 55 Post-Graduate Courses* were given as scheduled. The one cancellation was due to the inability of the instructor to get to Boston because of illness. In general the courses were well filled—many being sold out before the meeting started.

All original papers were presented as scheduled during the general meetings of the Academy.† These papers will appear in coming issues of this publication.

The Contact Lens Symposium† as arranged by Dr. Bernard Mazow, Houston, Texas, chairman of the Section on Contact Lenses and Subnormal Vision, was presented to an overflow audience on Sunday afternoon. More than 500 optometrists were present and the team composed of Drs. Mazow, Graham, Finkelstein, Neill, Policoff and Filderman did a splendid job, going far beyond most expectations. A group fom the Massachusetts Society of Optometrists were guests of the Academy at this afternoon symposium.

THE FORMAL ROUND TABLE DINNER

Two outstanding speakers made the Round Table Dinner most successful. Dr. Hoyt S. Purvis, Jonesboro, Arkansas, a member of the Academy and president of the American Optometric Association, discussed the present status of the profession and Dr. Thomas H. Eames, Department of Education, University of Boston, talked about the relationship of vision to learning. Both talks were well received and will appear in the literature. During the introduction of guests at the head table, Dr. Carel C. Koch, Minneapolis, was presented with the Phi

*V. J. Ellerbrock et al. American Academy of Optometry Post-Graduate Courses. Statler Hilton Hotel, Boston, December 10, 11, 12, 1958. Am. J. Optom. & Arch. Am. Acad. Optom. 35, 8, 439-448, 1958.

†Ralph E. Wick. Announcement of Program for American Academy of Optometry. Statler Hilton Hotel, Boston, December 13, 14, 15, 16, 1958. Am. J. Optom. & Arch. Am. Acad. Optom. 35, 10, 554-556, 1958.

Theta Episilon Fraternity Memorial Trophy for his contributions to the profession. The presentation was made on behalf of the fraternity by Dr. John C. Neill of the faculty of the Pennsylvania State College of Optometry. Dr. Robert W. Tubesing, immediate past president, presided at the dinner meeting and received a gift from the membership in appreciation for his splendid leadership during the past two years. Dr. Harold Simmerman, chairman of the Committee on Admittance, then introduced a group of Academy applicants who had successfully completed their work and who had just become newly elected Fellows of the Academy. These new members are:

Dr. C. Glynn Capps, 911 N. Palmer St., Plant City, Florida.
Dr. Ralph P. Carifa, 2533 Summit St., Columbus, Ohio.
Dr. I. William Collins, 602 High St., Pottstown, Pennsylvania.
Dr. John V. Donaldson, 9 N. Main St., Carrollton, Missouri.
Dr. Irvine L. Dubow, 124 E. Broadway, Little Falls, Minnesota.
Dr. Austin Duffy, 93 Main St., Southington, Connecticut.
Dr. Milton J. Eger, 344 Franklin Ave., Aliquippa, Pennsylvania.
Dr. Donald C. Exford, 74 North St., Pittsfield, Massachusetts.
Dr. Clif. R. Ferguson, 916 Diamond Square, Meadville, Pennsylvania.
Dr. Nathan Flax, 821 Franklin Ave., Garden City, New York.
Dr. Elmer S. Friedberg, 7 N. Hanover St., Pottstown, Pennsylvania.
Dr. Harold L. Friedenberg, 309 N. Second St., Richmond, Virginia.
Dr. Herman H. Gerdes, Jr., 1018 Washington Ave., Waco, Texas.
Dr. L. Kanofsky, 217 E. State St., Kennett Square, Pennsylvania.
Dr. Howard A. Kress, Mary Ann Bldg., Burgettstown, Pennsylvania.
Dr. Bernard Kushner, 6103 Lansdowne Ave., Philadelphia, Pennsylvania.
Dr. Rub'n I. Jaffe, 7 Islington St., Portsmouth, New Hampshire.
Dr. Leo J. Lemoi, 24 Curson St., West Warwick, Rhode Island.
Dr. Isaac Newman Lozier, Jr., 107 Monroe St., Dublin, Georgia.
Dr. William Ludlam, 884 West End Ave., New York, New York.
Dr. Bert O. Miller, 1919 West 7th St., Little Rock, Arkansas.
Dr. Joseph W. Moore, 154 High St., Wareham, Massachusetts.
Dr. Harry C. Morgan, 618 Braddock Ave., Braddock, Pennsylvania.
Dr. Adelbert O. Parrott, 302 Granite Block, Fall River, Massachusetts.
Dr. E. David Pollock, 1930 Chestnut St., Philadelphia, Pennsylvania.
Dr. Everett L. Porter, 106 High St., Belfast, Maine.
Dr. George E. Rimby, 803 Church St., Royersford, Pennsylvania.
Dr. George V. Stephens, 3075 Peachtree Road N. E., Atlanta, Georgia.
Dr. Stanley Wallman, 5398 Palm Ave., Hialeah, Florida.

IN RETROSPECT

Now that it is over and part of the history of the Academy we can say with pleasure that it was a fine meeting. Of course we had our ups and downs. Going to Boston our travel party, Dan Hummel, Rudy Ehrenberg, GiGi and I arrived a day early on a cold gloomy Tuesday afternoon. The train was four hours late and some well meaning idiot arranged to have us put out of our car at a suburban Boston station. There we stood in the snow, surrounded by a mountain of luggage and no red-caps to move it for us. At first I loathed Boston on sight, but after we arrived in a fleet of cabs at the Statler Hilton, things improved. The hotel people did a fine job for the Academy and when GiGi and I

returned to Minneapolis nearly two weeks later we were almost homesick for the place. For us the magic lamp of Boston hospitality was rubbed by Dr. Ralph H. Green, dean, Massachusetts College of Optometry, his fine faculty and student body—and by the attendance of so many Academy members.

CAREL C. KOCH

FITCH APPOINTS ACADEMY COMMITTEES

Dr. Lawrence Fitch, president, American Academy of Optometry, has appointed the following Academy Committees:

PAPERS AND PROGRAM COMMITTEE: Dr. Donald E. Springer, Anniston, Alabama, chairman; Dr. John Zettel, Jr., Cincinnati, Ohio, vice-chairman; Dr. G. W. Clay, Ardmore, Oklahoma; Dr. Alfred A. Rosenbloom, Chicago.

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SECTION ON CONTACT LENSES AND SUBNORMAL VISION AIDS: Dr. Robert C. Graham, Pasadena, California, chairman; Dr. Daniel O. Elliott, Jr., South Bend, Indiana; Dr. Bernard Mazow, Houston; Dr. John C. Neill, Philadelphia; Dr. William W. Policoff, Wilkes-Barre, Pennsylvania; Dr. I. Weiss, New Britain, Connecticut; Dr. Harold Moss, Woodbridge, New Jersey.

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ANNUAL REPORT OF THE PRESIDENT*

Robert W. Tubesing†
Richmond, Indiana

The activities of this office during the past year have been directed largely in two general areas, i.e., bringing the Academy story to optometrists, optometry students and other non-Academy members, and enlarging the Academy program.

Dr. J. Fred Andreae and Dr. Allie Trussel arranged an Academy luncheon in Washington, D. C., in connection with the Congress of the American Optometric Association in June. About seventy-five members and guests heard your president discuss "The Value of Academy Fellowship" and also heard Dr. Lawrence Fitch, our vice-president, discuss "The Requirements for Academy Fellowship." During the Congress, the Academy story was presented by an exhibit arranged by Dr. Leon Candeub of Pennsylvania State College of Optometry. A feature of the October issue of the JOURNAL OF THE AMERICAN OPTOMETRIC ASSOCIATION was an article giving the history, purpose and program of the Academy.

In June, your president gave the Commencement Address at the Pennsylvania State College of Optometry. Earlier in the year he addressed the optometry students at Ohio State University and Indiana University.

Under the direction of Dr. Donald Kratz, chairman of the Committee on Student Counsel, a letter of greeting was sent to each graduating senior in the optometric colleges.

Recommendations were made to Dr. Eldon Jerome and Dr. Gordon H. Seger of the National Institutes of Health that an optometrist be named on one of the committees of the National Institutes of Health having to do with visual science and physiological optics.

Following the request of Dr. Dael Wolfe, Executive Director of the American Association for the Advancement of Science, a letter recommending the appointment of Dr. Henry Hofstetter to the parliament of science meeting in Washington, D. C., was sent to Dr. Allan D. Bass of Vanderbilt University, chairman of Section N of the A.A.A.S.

Acting on the request of the Executive Council to the Section on

*Read before the annual meeting of the American Academy of Optometry, Boston, Massachusetts, December 13, 1958. For publication in the January, 1959, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist, Fellow, American Academy of Optometry.

Pathology for the development of a Home Study Course on Glaucoma. Dr. Arthur Shlaifer has completed the first draft of the nine sections. This is an important step in the expansion of Academy activities into the field of home study courses. I heartily recommend that proper arrangements be made to publish and distribute the courses on glaucoma and further that a chairman for the Home Study Courses be appointed to supervise and expand this new field of Academy endeavor.

The Memorial Medal Award Committee has recommended that the Memorial Medal be named to honor Charles Prentice, M.E. The award of this medal is to be made in accordance with the Committee's previous recommendation that the recipient should be chosen biennially on the basis of his advancement of the knowledge of visual science. The Committee further recommends that the recipient be invited to give a lecture. I suggest that this report be accepted, that the medal be struck, and that a standing committee be selected to choose the recipients.

The Academy has received a print of Dr. Jose Barraquer's film on corneal transplantations as a gift from Dr. G. W. Clay of Ardmore, Oklahoma. This generous gift is to be used by Fellows of the Academy to help in the development of the eye bank program. The film may be borrowed by members through the Section on Pathology.

You have just completed a most successful series of fifty-four post-graduate courses. These courses were presented under the direction of a strong committee and a large number of very fine instructors. This is the fourth presentation of these courses which are now an important part of the Academy program.

Shortly you will hear from Dr. Ralph Wick, chairman of the Program and Papers Committee, and Dr. Donald Springer, in charge of the Sections, who will outline for you the outstanding programs they have prepared for you.

From time to time my attention has been brought to statements that certain portions of the Academy program encourage optometrists to expand their services beyond their legitimate areas of responsibility. Optometry has developed from a background of physics, optics, physiology and psychology. Because it has rendered a significant service to the public, optometry has grown to its present position in our society. It is to be expected that when its services lie adjacent to or overlap those of other professions, some misunderstanding will occur. The Academy program dealing with these adjacent or overlapping areas has been designed for the sole purpose of giving optometrists the knowledge necessary to recognize those conditions outside their areas of responsibility so that proper referral can be made. Thus, this part of the

Academy program is designed for the protection of the public—not for optometric expansion. The Academy, with its membership, including educators and scientists interested in visual matters who are not optometrists, is in a particularly fortunate position to offer responsible and uncensored discussion in these areas.

I wish to thank the team of Executive Council members, chairmen and committeemen who have worked together so diligently to make the Academy program a success this year. Particularly, do I wish to thank our secretary-treasurer, Dr. Carel C. Koch, who not only has carried out his duties faithfully, but has given the Academy program continuity throughout these many years. I wish to thank the Fellows of the Academy for the privilege of serving as your president during the past two years and as a member of the Executive Council the seven previous years. This has been a rewarding experience which will always be remembered.

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SECTION ON CONTACT LENSES

FOUR NEW APPLICANTS REACH DIPLOMATE STATUS

At the Boston meeting, the examining committee of the Section on Contact Lenses announced that four Academy members had during 1958 completed their work and had become Diplomates of the Section in Contact Lens Fitting. These men are:

Dr. Harry Kaplan, Philadelphia, Pennsylvania
Dr. Mordicai Katzin, Jacksonville, North Carolina
Dr. Franklin A. Warren, Waterbury, Connecticut
Dr. Robert Jay Morrison, Harrisburg, Pennsylvania

To become a Diplomate of the Section, an applying optometrist who is a member of the Academy, must have completed an on-campus post-graduate course in the fundamentals of contact lens fitting; next, successfully completed fitting 100 clinical contact lens cases, 25 of which must be fully written up and submitted to the committee for study, and finally must pass a comprehensive clinical examination, given by the examiners, covering various types of contact lens fitting. Academy members wishing to complete their work at Chicago next December should apply now to the Section for instructions.

CURRENT COMMENTS

Terry Judith Parkins
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department; such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

PENNSYLVANIA OPTOMETRIC ASSOCIATION REVIEW OF PATHOLOGY

The Department of Education of the Pennsylvania Optometric Association will sponsor a symposium on a "Review of Optometric Recognition of Pathology" in Philadelphia on Sunday, February 22, 1959, at 10 A.M. The symposium will be presented at the Pennsylvania State College of Optometry. The symposium will feature educators from the Pennsylvania State College of Optometry.

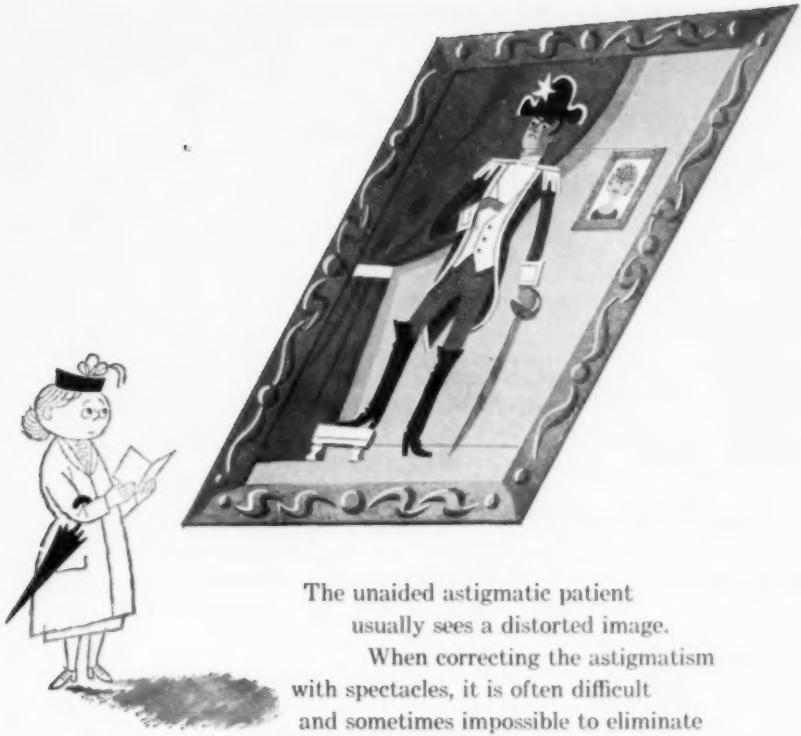
Harold Simmerman, O.D., professor of Ocular Pathology, will discuss "The Optometric Diagnosis of Systemic Pathology Through the Study of the Eye." The ocular clues to pathologies such as diabetes, hypertension, syphillis, and cranial tumors will be discussed. The initial findings which may enable the optometrist to be the first practitioner to suspect the pathology will be thoroughly described.

Arthur Shlaifer, O.D., Ph.D., associate professor of Ocular Pathology, will discuss "Psychosomatic Aspects of Optometric Practice."

A general ocular pathology outline will be followed by both professors which will consist of an overall review of pathology with emphasis on those anomalies which are more frequently encountered. Emphasis will be placed on corneal pathology which may be of special interest for contact lens work. In view of the recent interest in the visual problems of the aged, a special reference will be made to ocular pathology in this group. Special visual aids—slides—will be used throughout the symposium.

This will then be followed by a "workshop" in Multiple Pattern Screening—and screeners from the Roberts Instrument Company will be distributed so that each member of the audience will have an opportunity to be both subject and observer in the use of the instrument. The topic of Glaucoma will then be given detailed discussion with respect to diagnostic clues.

Advanced registration should be made immediately through E. Payson Smith, Executive Secretary, Pennsylvania Optometric Association, 229 State Street, Harrisburg, Pennsylvania. Registration fee for members is $5.00. Dr. Bernard Kushner, vice-president of the Association in charge of education, is in charge of the symposium.



The unaided astigmatic patient usually sees a distorted image. When correcting the astigmatism with spectacles, it is often difficult and sometimes impossible to eliminate the distortion because of the distance between the spectacle lens and the cornea.

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Dr. Sheard was formerly editor of the *American Journal of Physiological Optics* and for many years director of the Department of Biophysics, The Mayo Foundation. The book contains 83 illustrations, 476 pages, $15.00.

CONTENTS

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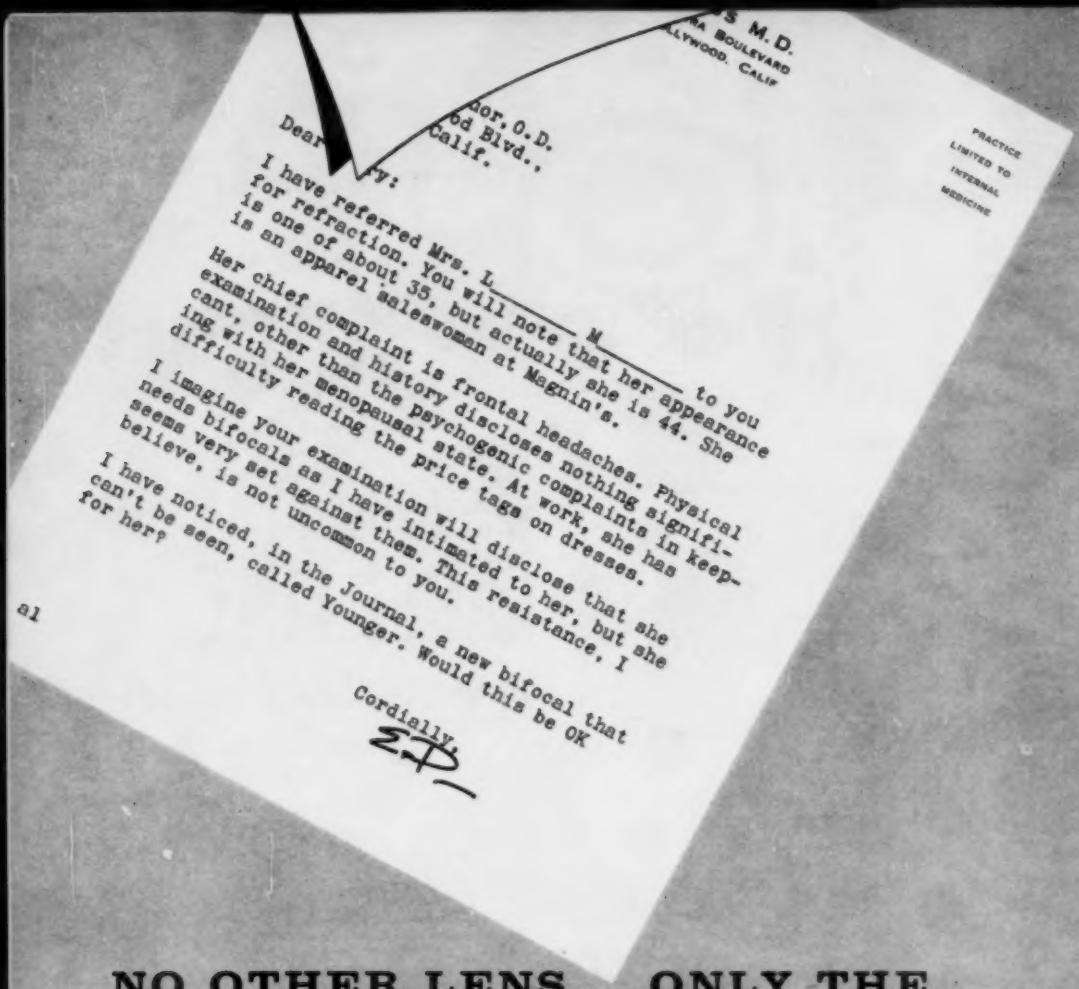
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